FAIRCHILD

ELECTRO-METRICS CORPORATION

MP MASTER

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Use of Interference Analyzer

EMC-25, EMC-25R or EMC-25RN

for Measurements to MIL-STD-826A (USAF)

Index

1.0 Electromagnetic Interference - General

1.1 Electromagnetic Interference

1.2 Types of Electromagnetic Interference

1.2.1 Narrowband Interference

1.2.1.1 Local Oscillator Radiation

1.2.1.2 Harmonic Generation

1.2.1.3 Spurious Interference Generation

1.2.1.4 Elimination or Reduction of Narrowband Interference

1.2.2 Broadband Interference

1.2.2.1 Transients

1.2.2.2 Interference Caused by Natural Phenomena

1.2.2.3 Reduction or Elimination of Broadband Interference

2.0 Electromagnetic Interference Measurement - General

2.1 Need for Measurements

2.2 Propagation of Interference

2.2.1 Radiated Interference

2.2.2 Conducted Interference

2.3 Basic Units for Narrowband Measurements

2.3.1 The Electric Field

2.3.2 The Magnetic Field

2.4 Basic Units for Broadband Measurements

2.5 Far-Field/Near-Field Measurements

2.6 Pickup Devices

2.6.1 Field Sensitivity

2.6.2 Polarization

2.6.3 Aperture Size and Shape

2.6.4 Coupling

2.7 Calibration of Pickup Devices

2.7.1 Standard Field Calibration

2.7.2 Dummy Antenna Method

2.7.3 Standard Antenna Method

2.7.4 Substitution Method

2.7.5 Identical Antenna Method

2.8 The EMI Receiver

2.8.1 Receiver Sensitivity

2.8.2 Receiver Selectivity

2.8.3 Tuning Range

2.8.4 Detection of Signals

2.8.4.1 Log Detection

2.8.4.2 Carrier Detection

2.8.4.3 Peak Detection

2.8.4.4 Quasi-Peak Detection

2.8.4.5 Slideback

2.8.5 Receiver Outputs

2.8.6 Receiver Calibration

2.8.6.1 The Impulse Generator

2.8.7 Automatic and Semiautomatic EMI Measurements

2.8.8 The Model EMC-25R Interference Analyzer

2.9 Recording and Monitoring Devices

2.9.1 The X-Y Recorder

2.9.2 The Spectrum Analyzer

2.9.3 Fully Automated Systems

3.0 MIL-STD-826

4.0 Specifications of Model EMC-25 Receiver

4.1 General

4.2 Control Functions

4.3 Calibration of the Model EMC-25

5.0 The Model SPD-125 Spectrum Display Module

5.1 General

5.2 Interconnections

5.3 Control Functions

6.0 X-Y Recorder

6.1 General

6.2 X-Y Recorder Specifications

6.3 Model EXY-125A Recorder

6.3.1 Input Connections

7.0 Other Accessory Equipment

7.1 Connector Junction Box, Model CJB-25

7.2 Impulse Generator Calibrator

7.2.1 The Model CLC-25 Impulse Generator Calibrator

7.2.2 Use of an External Impulse Generator

7.3 Pickup Devices

7.3.1 Clamp-on Current Probe, Model PCL-25

7.3.2 Vertical Rod Antenna, Model RVA-25

7.3.3 Broadband Dipole, Model BDA-25

7.3.4 Log Conical Antenna, Model LCA-25

7.3.5 Input Cable Insertion Loss

8.0 Test Procedure - Conducted Interference Measurements MIL-STD-826A Method 3002

8.1 Test Equipment Required

8.2 Procedure for Making Calibration Master Plot

8.2.1 General

8.2.2 Equipment Setup

8.2.3 Explanation of Tables 3002-1 & 3002-2

8.2.4 Initial Control Settings

8.2.5 Plotting Paper

8.2.6 X-Y Recorder Adjustment

8.2.7 Model SPD-125 Adjustment

8.2.8 Frequency Calibration of Master Plot

8.2.9 Amplitude Calibration of Master Plot

8.2.10 Final Preparation of Master Plot

8.2.11 Master Plots Required

8.2.12 Use of Master Plots

8.2.13 Reproduction of Master Plots

8.3 Conducted Interference Measurements - MIL-STD-826 Method 3002

8.3.1 Test Sample Setup

8.3.2 Measuring Equipment Setup

8.3.3 Initial Control Settings

8.3.4 X-Y Recorder Gain and Zero Adjustments

8.3.5 Model EMC-25 Receiver Amplitude Calibration

8.3.6 Model SPD-125 Spectrum Analyzer Adjustment

8.4 MIL-STD-826 Method 3002 Required Measurements

8.5 Initial Spectrum Surveillance

8.5.1 Frequency Scanning using the Model SPD-125 (Broadband)

8.5.2 Interpretation of the Model SPD-125 Display

8.5.3 Frequency Scanning for Narrowband Responses

8.5.4 Bandwidth Determination of Responses

8.5.5 Accurate Amplitude Determination using the Model SPD-125

8.5.6 Measurement of other Conductors

8.5.7 Measurement of other Frequency Bands

8.6 Procedure for Making X-Y Recordings

8.6.1 General

8.6.2 Broadband Conducted X-Y Recordings

8.6.3 Inspection of Recording

8.6.4 Information to be included on Recording

8.6.5 Identification of Transient Responses

8.6.6 Bandwidth Classification of Recorded Responses

8.6.7 Measurements on other Conductors

8.6.8 Narrowband Conducted X-Y Recordings

8.6.9 Measurements on other Frequency Bands

8.7 Use of Completed X-Y Recordings

1.0 Electromagnetic Interference - General

Both this section and the next are intended only as a very basic introduction to interference testing; these two sections, however, should prove useful to anyone becoming involved in such testing for the first time.

1.1 Electromagnetic Interference (EMI) can be broadly defined as any electrical emanation which adversely affects the proper operation of any device. This interference may be intentional, as in the case of a noise jammer used to disable the communications, or radar of an unfriendly power. It may be inadvertent, as is the case of the output of one transmitter interfering with the successful communication between two other stations, or it may be generated completely unintentionally, such as the arcing of a sewing machine's motor brushes interfering with someone's enjoyment of a television program.

As the usable frequency spectrum becomes more crowded, and as electronic systems become more sophiscated and interdependent, it becomes increasingly important to locate and eliminate sources of unwanted interference. In the military, control and elimination of electrical interference is especially crucial. Undesirable radiation of a receiver's local oscillator or the interference caused by the ignition system of a vehicle may disclose the position and purpose of a military operation to the enemy's surveillance. The arcing of a poor electrical contact may so affect the control and monitoring of a moon rocket's functions as to cause a failure of the launch.

1.2 Types of Electromagnetic Interference

1.2.1 Narrowband Interference

This type of interference is energy radiated at a single frequency or a very narrowband of frequencies. Unmodulated or voice-amplitude-modulated sinewave carriers can be examples of this type of interference. Narrowband interference may be caused by

transmitters operating outside their frequency tolerance, by "bandit" radio stations (amateurs, experimenters, etc.) operating on unassigned frequencies. The majority of this type of interference, however, is caused by leakage from improperly-adjusted, improperly-grounded, improperly-designed, improperly-shielded or faulty electronic equipment. The interference may be propagated by radiating through the equipment's case or enclosure, by being radiated from the equipment's input circuits (antenna, etc.), or it may travel through control, output or power input cables. A few of the more common sources of narrowband interference are discussed below.

1.2.1.1 Local Oscillator Radiation

The local oscillator of any superheterodyne receiver may cause troublesome interference if it is not well isolated from the input circuit of the receiver, if the receiver is not well shielded and/or grounded, if the local oscillator level is too high or if the power, control and output cables are not properly filtered.

1.2.1.2 Harmonic Generation

This category covers a wide range of possible interference generation. An improperly-tuned, improperly-loaded or improperly-terminated transmitting device may generate many harmonics (multiples of the fundamental frequency) and radiate these from its antenna. Many transmitting and receiving devices have a master oscillator operating at a low frequency, which is multiplied by means of harmonic generators or frequency multipliers. If the unused fundamental or harmonics are not properly suppressed, such a device can be a serious source of interference. A pure sinewave voltage developed by a device may become distorted by non-linear circuitry of the device, generating harmonics. Purposely non-sinusoidal voltages developed by a device (sawtooth, square waves, etc.) have very high harmonic content and must not be allowed to radiate into the surrounding area, or to be conducted via power lines, unshielded control lines, etc.

1.2.1.3 Spurious Interference Generation

This category covers unwanted interference frequencies generated as the mixing or cross product of two or more desired frequencies, as well as the spontaneous generation of unwanted frequencies due to inadvertant resonances and feed-back loops within the device. Such spurious oscillations may not appear to interfere with the device itself, but may be propagated through its case or cabling to interfere with the operation of nearby equipment.

1.2.1.4 Elimination or Reduction of Narrowband Interference

The exact cause of origination of this interference must first be established. High-pass, low-pass and band-pass filtering, resonant traps, decoupling, shielding and proper grounding are some of the means used to either eliminate this interference or reduce it to a tolerable level. Sometimes a major redesign of the interference-causing device is necessary.

1.2.2 Broadband Interference

This type of interference is typically generated by a sudden discharge of electrical energy, developing an impulse of electromagnetic radiation having frequency components covering a very wide spectrum.

The energy content, the high and low frequency limits and the energy distribution within the spectrum of this type of interference are determined by the rise and fall time, the pulse width, the repetition rate and the amplitude of the impulse generated by the electrical discharge. Broadband interference is commonly caused by arcing brushes of motors and generators, by ignition systems such as used in internal combustion engines, by arc-discharge lights (fluorescent lamps, etc.) and by electro-mechanical devices such as vibrators, interrupters and buzzers.

Electronic equipment such as power supplies, pulse generators, wave shapers, voltage regulators, differentiators and multivibrators, may generate steep-sided repitious pulses resulting in broadband interference. Repetitious static discharges such as may occur through the generation of static charges in machinery, or by the friction of air against a moving vehicle can also cause this type of interference.

Noise generators and impulse generators (which will be discussed later) are cases of broadband noise being deliberately generated for use as a calibration standard.

1.2.2.1 Transients

A broadband impulse is termed a "transient" if it occurs only intermittently or sporadically in response to switch or contact closures.

1.2.2.2 Interference Caused by Natural Phenomena

This type of interference is usually broadband and may be either transient or irregularly repetitious. A lightning discharge is a common example of natural transient interference generation. Static charges built up on insulated guy wires, of ships or planes due to the friction of air across them, arc across their insulators, causing interference. Electrical discharges within ionized layers of air such as the northern lights and St. Elmo's fire generate interference. The failures of communications during such natural phenomena as sun spot storms is, however, not due so much to any spontaneous generation of interference as it is to the changes in propagation paths such conditions cause.

1.2.2.3 Reduction and/or Elimination of Broadband Interference

The source of the offending interference must first be pin-pointed, as this type of interference should be eliminated at its source if possible, and because the type of fix required depends on the generating source. Such corrective measures as broadband

or "brute force" filtering, arc suppression, shielding, decoupling and grounding are used to reduce or eliminate the interference. Sometimes the interference generating device must be replaced with one which performs the same or similar functions but does not generate objectional interference. Thus, a solid-state device may be substituted for a switch, a brushless AC motor substituted for a brush-type motor or an incandescant lamp substituted for a fluorescent lamp.

2.0 Electromagnetic Interference Measurement - General

2.1 Need for Measurements

In order to keep interference below levels which will adversely affect the operation of other devices, procedures must be adopted establishing the parameters to be measured and defining the units of the measurements to be made. These procedures should be such that meaningful accurate and repeatable measurements can be made at different locations by different equipment and personnel. Next, limits must be set for the various types of interference, specifying the maximum permissible levels over the frequency bands of interest. These limits should be realistic, taking into consideration the susceptibility to interference of other devices in the area and the relative importance of their functions. A man alone on a desert island having no devices whose operation is affected by interference need not worry about the interference he may be creating. On the other hand, the smallest interference source in the center of a complex communications center may have catastrophic effects.

The limits, therefore, must be flexible enough to provide interference protection for the most sensitive and crucial of installations, while not unduly restricting the design of devices to be used in areas of less sensitivity. Various government agencies, various branches of each of the military services, and commercial organizations have all established sets of interference limits at various times, which differ depending on their unique respective requirements.

2.2 Propagation of Electrical Interference

Electrical energy may travel from the interference-generating device to the interference-susceptible device by either radiation or conduction, or a combination of both.

2.2.1 Radiated Interference

Electrical energy may be radiated through space by means of an electrostatic field alone, by means of a magnetic field alone, but usually through a combination of both. Propagation by the electric field (capacitive coupling) alone or the magnetic field (inductive coupling) alone are relatively local in nature because the energy stored in the field is returned to the source when the field collapses. Electromagnetic radiation consisting of alternate electric and magnetic fields is not local in nature, as the energy contained in these fields is not returned to the source, but is radiated as a radio wave. High levels of interference may be radiated from devices for various reasons.

A. High Electrical-Energy Devices

In devices handling very high energy levels, the conversion of only a very small percentage of the energy into electromagnetic energy may produce troublesome interference. Such a device should be very well shielded and filtered and every precaution taken to prevent high-energy electrical discharges.

B. Coupling to Efficient Radiators

A device which potentially develops only very low levels of interference may cause trouble if these low levels are efficiently radiated into the surrounding area by being coupled to efficient electromagnetic radiators. Long, unshielded wires, resonant lengths of wires, resonant cavities, improperly-terminated transmission lines and open-circuited control lines may all become efficient radiators at various frequencies.

C. Spark Discharge

In an electrical discharge through a vacuum or an ionized gas, a high percentage of the energy dissipated is converted directly into electromagnetic energy.

2.2.2 Conducted Interference

Any changes in the electrical energy levels within a device potentially generate interference. This interference may travel through any conductors connected to the device and, therefore, may travel to an interference-susceptible device through any common conductor. Because the interference is generally confined to the conductor through which it is being propagated, its energy content is concentrated, and comparatively small levels may cause malfunctions in susceptible devices. This interference may travel through power lines, control lines, input and output lines, and through common ground connections.

2.3 Basic Units for Narrowband Measurements

Any meaningful measurement of interference must indicate the energy content of the interference signal, its frequency spectrum and its means of propagation. By its definition, the energy contained in narrowband interference is concentrated at or near a single frequency. The energy contained in a radiated electromagnetic wave is stored within the electromagnetic and electrostatic lines of force that comprise it.

2.3.1 The Electric Field

A basic electrical force unit is the volt. Therefore, the basic unit of measurement of the electrostatic field force is usually the volt although other units such as the abvolt or statvolt may be used. The electrical force at a single point cannot be defined, since a force exists only as a difference in energy levels between two points. Therefore the force of an electric field in space is defined as the electric potential developed between two points in space, separated by a known-distance, and measured in the direction of

the electrostatic lines of force. The basic unit for this measurement is volts per meter and is the electrical potential difference between two points in space separated by one meter. This is called the Field Intensity. The energy of the field depends upon the force of the field and/or the dielectric of the medium through which the force is exerted. Since we are now discussing an electric field in space, and since the dielectric of space (including air) is a constant which varies only slightly with atmospheric conditions the measurement of the electric potential of a field in volts/meter is an indication of the energy contained in the field.

A smaller and more useful unit for most applications is the uV/meter (microvolt per meter). Most often, field intensity levels are expressed in terms of decibels above 1 uV per meter (or dB uV/M). In many cases, test equipment is calibrated in terms of dB uV. A value expressed in terms of uV/M can be converted into dB uV/meter by using the formula E (in dB uV/meter) = 20 log E (in uV/meter). When a quantity is expressed in dB uV/M, a positive sign indicates the quantity is greater than 1 uV/M and a negative sign indicates the quantity is less than 1 uV/M.

For Example: + 20 dB uV/M = 10 uV/M

- 20 dB uV/M = 0.1 uV/M

+ 60 dB uV/M = 1000 uV/M

- 60 dB uV/M = .001 uV/M

Tables are commonly available so that this conversion can be made easily. Because of its logarithmic nature, many calculations are greatly simplified by expressing quantities in dB uV. The multiplication of two quantities becomes a simple addition when these quantities are expressed in dB, and the division of two quantities becomes a simple subtraction.

That is: 200 uV/M x 1000 = 200,000 uV/M becomes, when expressed in dB values,

+ 46 dB uV/M + 60 dB = 106 dB uV/M; also

1000 uV/M x 2000 = 0.5 uV/M becomes, when expressed in dB values,

+ 60 dB uV/M - (+66 dB) = -6 dB uV/M

2.3.2 The Magnetic Field

A basic unit for measuring magnetic force is the ampere turn. As was the case with the measurement of the electric field, measurement of the magnetic field in space can be defined as a force existing between two points in space separated by a known distance and measured in the direction of the magnetic lines of force. This is the magnetic field intensity and the basic unit for this measurement is ampere-turns-per/meter (At/M) . Occasionally, other basic units are used. Ampere turns/meter can be converted to Oersteds by means of a conversion factor. The magnetic energy or flux density contained within the field is a function of the magnetic force and the permeability of the medium through which the force is exerted.

Because the permeability of free space is a constant, the field intensity (measured in at/m) can be converted into flux density (measured in teslas), by a conversion factor:

$B = H\ 1.25 \times 10^{-6}$

where B is the magnetic flux density in teslas

H is the magnetic field intensity in at/M and the constant 1.25×10^{-6} is the permeability of free space. This constant has the unit of henry/meter. Magnetic field intensity is commonly expressed in terms of decibels above one microampere turn per meter, and symbolized as dBuAt/M, or more simply, dB uA/M.

2.4 Basic Units for Broadband Measurements

When discussing narrowband measurements of field intensity it was assumed that all the energy in the field being measured was concentrated about a single frequency. This is not true of broadband interference fields. Broadband interference consists generally of a large number of different frequency components covering a wide frequency spectrum. Any definition for a basic measurement unit for broadband measurements must therefore take the frequency distribution of the energy into consideration. This basic unit for field strength measurements now becomes volts per meter per hertz, or more practically microvolts per meter per megahertz. Except for the addition of the bandwidth factor (Hz), the same principles expressed in Section 2.3 for Narrowband apply equally for broadband fields.

2.5 Far-Field/Near-Field Measurements

At distances far from the radiating source (distances much greater than a wave length), the electric and magnetic fields are normal to each other and have relative field intensities which are expressed by the relationship:

$$E = 377H,$$

where E is the field intensity of the electric field, measured in volts/meter,

H is the field intensity of the magnetic field measured in ampere turns/meter,

and the constant, 377, is the impedance of free space (in ohms).

Therefore, in the far-field region, the intensity of the magnetic field can be deduced from a measurement of the electric field and vice-versa.

At distances close to the radiating source (distances much less than a wave length) the relative intensities and polarizations of the electric and magnetic fields cannot be easily defined as they depend upon the nature of the radiating source and the immediate environment. However, since it is often impractical or impossible to make

measurements in the far-field, near-field measurements are commonly made. It is a primary purpose of the various interference measurement specifications to carefully define the conditions under which these measurements are made, so that consistent and repeatable measurements can be achieved. The procedures thus established may be more or less arbitrary, and the quantities measured may not be fundamentally accurate. However, they do have quantitative significance for the purposes intended.

2.6 Pickup Devices

One of the most important considerations in any attempt to define an interference measurement procedure is the pickup device. In the far-field, almost any properly calibrated antenna can be used to make meaningful measurements. However, for near-field measurements, the pickup device must be exactly defined. Pickup devices which differ in the following fundamental ways may produce entirely different near-field measurements.

2.6.1 Field Sensitivity

An antenna may be primarily sensitive to the electric field, or it may be primarily sensitive to the magnetic field or require both fields for proper functioning.

2.6.2 Polarization

The complex polarization of the near-field signal can cause different results from antennas of different designs.

2.6.3 Effective Aperture Size and Shape

The form factor of the pickup device is important in determining its sensitivity to near-field signals.

2.6.4 Coupling

Because of the close coupling between the radiation source and the pickup device when making near-field measurements, the pickup device itself may affect either the

radiated field, or the radiating source.

2.7 Calibration of Pickup Devices - General

A receiving antenna is basically a transfer device which converts the energy contained in the electromagnetic field which it intercepts into a two-terminal AC electrical energy which can be conveniently measured. The conversion factor which translates the voltage measured at the output of the antenna into the field intensity of the signal it is intercepting is called the "antenna factor". This antenna factor typically includes the effective aperture of the antenna, its matching circuit, the losses in the transmission line connecting it to the receiver and any mismatch losses. The antenna factor is usually presented in the form of a table or graph, as it is frequency-dependent. Some of the general methods of calibrating or checking the calibration of antennas are as follows:

2.7.1 Standard Field Calibration

This method is generally used at lower frequencies to calibrate antennas sensitive to only the magnetic field. An accurate magnetic field can be generated by means of passing a known current through a transmitter loop antenna of known area. The antenna to be calibrated is placed at a known distance within this field, and its antenna factor established by comparing the output of the antenna to the known field intensity. This method is used to calibrate shielded loop antennas up to about 30 MHz. At higher frequencies, reflections tend to generate standing waves which affect the accuracy of the method. Because of the difficulties encountered in generating a standard electric field, this method is seldom used to calibrate antennas sensitive to the electric field.

2.7.2 Dummy Antenna Method

This means of calibration is generally used at lower frequencies to calibrate short rod antennas sensitive to the electric field. In a simple rod antenna whose length is

very short compared to a wave length, the voltage induced in the rod by the electric field depends almost entirely on the length of the antenna rod and the intensity of the field it intercepts. The source impedance of such an antenna is primarily capacitive and is largely dependent upon the length of the antenna rod. Since the antenna-induced voltage and source impedance can be mathematically determined, the variable in the calibration of such an antenna is the network which couples the antenna to the measuring instrument. It is, therefore, possible by using a calibrated signal source (to simulate the induced voltage) in series with the correct value of capacitance (to simulate the source impedance of the rod antenna) to inject a test signal directly into the antenna matching network. The antenna factor of the antenna is established by measuring the output of the antenna and comparing this with the simulated field strength of the injected signal. This method is seldom used at higher frequencies because the input impedance and induced voltage of the antenna cannot be so simply defined.

2.7.3 Standard Antenna Method

This method is used primarily at higher frequencies where far field measurements are more practical and where standard resonant antennas are available. A standard antenna is one constructed in such a way that its antenna factor depends only on simple physical laws and can be accurately determined mathematically. A tuned dipole constructed in such a way that the open circuit induced voltage can be measured is an example of such a standard antenna. The standard antenna is used to determine the strength of a field. The antenna to be calibrated is then placed in the same position and its output measured to determine its antenna factor. Such measurements should be made in the far-field of the transmitted signal.

2.7.4 Substitution Method

A reference antenna of known calibration is used to measure a field. Then, a

test antenna of similar construction is substituted and its calibration determined. This method is similar to the standard antenna calibration method except that a secondary standard is used. Near-field calibration measurements are possible if both the reference and test antennas are identical in construction and if care is taken to position both antennas identically.

2.7.5 Identical Antenna Method

One antenna is used as a transmitter and a second identical antenna is used as a receiver. The antennas are spaced so that far-field reception is obtained, and this spacing is noted. With a known power input to the transmitter antenna, and a known power output from the receiving antenna, the gain product of the two antennas can be determined. If the calibration of one antenna is known, or if it is assumed they are both entirely identical, the antenna factor can be obtained.

2.8 The Receiver

The receiver used in making EMC measurements is essentially a tuned two-terminal voltmeter, which is used to indicate the output from the pickup devices. Some of the requirements of the receiver are as follows:

2.8.1 Receiver Sensitivity

The sensitivity of the receiver should be as good as the other receiver requirements will permit so as to allow measurements of low level signals.

2.8.2 Receiver Selectivity

Tuned preselection is required to prevent image reception and mixer overloading. The receiver's bandpass should be narrow enough to distinguish between two closely spaced signals, but not so narrow as to severly limit the ease of signal acquisition. To obtain optimum bandwidths over the wide tuning range of the receiver, different

bandwidths are usually used on different RF frequency ranges. To obtain optimum operation for the many various applications it is desirable that the bandwidth be adjustable or selectable.

2.8.3 Receiver Tuning Range

For operating simplicity, it is desirable that a single receiver be capable of tuning over the entire frequency range of interest, with a minimum of operator adjustment.

2.8.4 Detection of Receiver Signals

It is in the detection circuitry of the receiver where the EMI receiver may depart most widely from conventional receiver design. Because of the variety of measurements required by various specifications, it is necessary to incorporate several different detector functions in the receiver. Some of the required or desired detection characteristics are as follows:

2.8.4.1 Log Detection: Because of the extremely wide range of input levels which may be encountered during the operation of a receiver it is desirable that the meter indication of the received signals be presented logarithmically. A wide range of signal levels may thus be identified without adjustment of the receiver gain and/or attenuator controls.

2.8.4.2 Carrier Detection: In this detection mode of operation the average of the peak level of a signal is presented on the front-panel meter. The meter is calibrated to measure the RMS level of a CW signal. This mode is usually used to measure CW, AM-modulated CW, and FM-modulated CW signals. Since the meter is calibrated in RMS, the meter indication is effectively a measurement of the average input power.

2.8.4.3 Peak Detection: In this mode the detector has a very fast rise time and a very slow decay time. The output meter indicates the peak level of any signal being received. The long decay time permits the measurement of short pulse-type of signals of isolated occurrence or with low repetition rates. The meter is calibrated in RMS levels. Therefore, the measurement is in terms of the RMS CW sinewave equivalent of the peak levels of the received signals. When an unmodulated CW signal is received, the measurements will be the same as for a Carrier detector. For an AM modulated signal the measurement will be the RMS value of the peak of the modulation envelope's amplitude. When a pulsed CW signal is received, the measurement is in terms of the RMS level of the peak pulse amplitude. When measuring broadband signals, the measurement is in terms of the RMS sinewave equivalent of the peak levels of broadband energy occupying the bandwidth of the receiver. Therefore, to make quantitative broadband measurements, the effective impulse bandwidth of the receiver must be known, or a calibrated impulse source substituted.

2.8.4.4 Quasi-Peak: The function of quasi-peak detection is similar to that of peak except that the rise time of the detector is slower and the decay time is faster. Some specifications require quasi-peak detection.

2.8.4.5 Slideback: In this mode of operation, a detector is biased by a DC voltage which acts as a squelch. The voltage is varied until the signal as heard in earphones, is just eliminated from audibility and the meter (which is monitoring the DC bias voltage) indicates the signal amplitude. Using this means of detection, the amplitude of signals below the noise level of the receiver can be determined.

2.8.5 Receiver Outputs and Output Indications

A. All receivers to be used for EMI measurements should have meters to indicate the output. It is also desirable to be able to connect a meter for remote indication.

B. The receiver should have a phone jack for monitoring the audio modulation of the received signal.

c. It is desirable, and with many of the newer specifications necessary, that the receiver have provisions so that its output can be recorded.

2.8.6 Receiver Calibration

In order to determine accurately the level being measured by the receiver, a means of calibrating it is required. A simple and accurate calibration can be obtained through the use of a calibrated signal source whose output level is monitored by a power meter. However, to calibrate a receiver at each frequency by this means requires a large expenditure of time and the extended use of a considerable amount of expensive equipment. Many receivers use an impulse generator as a transfer standard. After an initial calibration, which involves comparing the receiver's response to the output of an impulse generator to the receiver's response to a known sinewave input and drawing calibration curves from the results, the impulse generator is used as the calibration standard.

2.8.6.1 The Impulse Generator: An impulse generator is basically a device which generates steep-sided, narrow impulses of a known amplitude and repetition rate. Such impulses contain frequency components of uniform amplitude distributed uniformly throughout the usable frequency range of the generator. The amplitude of each of the frequency components is determined primarily by the impulse amplitude and width. The high frequency limit of such a device is determined by the impulse width, and the rise and fall times of the pulse. The low frequency limit is determined primarily by the repetition rate of the generator, as is the distribution of the frequency components within the usable range of the unit.

An impulse generator is commonly an electro-mechanical device in which a short length of transmission line is charged (through a large resistor) by a DC voltage. A mechanical contact closure discharges the line into a resistive load of known attenuation and then to the receiver input. The contacts are usually opened and closed by a coil driven by a multivibrator.

In such a device, the impulse amplitude is determined only by the DC voltage supplied. The pulse width is determined only by the electrical length of the charged line. The impulse rise and fall times are very short, as they are determined by the mechanical contact closure, and to some extent the charged line characteristics. The repetition rate is established by the multivibrator. Since all of the parameters that determine the frequency component distribution and amplitude are determined by easily controllable physical and electrical quantities, impulse generators can be constructed having stable, predictable and consistent outputs.

2.8.7 Automatic and Semiautomated use of the EMI Receiver

Manual EMI measurements over wide frequency ranges are laborious and time consuming. After the initial setup of the equipments, they involve the slow and careful tuning across each frequency band, in a search for responses. Receiver bands, tuning units, antenna switches and antennas typically must be switched and adjusted. For each response received, the system must be calibrated to make a quantitative measurement.

To reduce the time, expense and chance for human error involved in making these measurements, automated and semiautomated techniques have been developed. Such automated procedures generally involve sweeping across a frequency band while registering any responses on an X-Y recorder. Bandswitching of receivers and antennas can be performed remotely and automatically. A device can be used to program and record a measurement across the entire frequency range automatically.

To be usable in such a semiautomatic or automatic system a receiver should contain the following features.

A. Automatic Frequency Scanning

Motor drives may be added to a mechanically tuned receiver to tune it across a band. However, such arrangements are cumbersome, complicated and relatively slow. The ideal solution is a receiver which is entirely electronically tuned. Such a receiver can sweep an entire frequency band in as little as a fraction of a second. A sweep voltage generated in the receiver itself or in the auxiliary recording or monitoring equipment controls the frequency tuning. The output of the receiver is fed to the monitoring device to be presented on a scope presentation or on an X-Y recorder plot.

B. The various detector functions of the receiver must have a fast enough response to record signals accurately. The peak detector circuitry must be such that it can accurately record the level of impulse-type interference on a relatively slow response X-Y recorder, without obliterating other nearby responses which may be lower in amplitude.

C. One possible limitation to the maximum speed at which a receiver may be swept is the bandwidth of the receiver. It is desirable that a receiver have two or more selectable bandwidths to increase its flexibility.

D. It is desirable that the frequency bands of the receiver be remotely selectable so that automatic band switching is possible.

E. It is desirable that the receiver be capable of switching the band position of remotely controllable antennas to permit semiautomatic and automatic operation.

F. It is necessary for the receiver to have a means of establishing calibration levels for the auxiliary recording devices so the amplitude of the responses recorded can be determined.

2.8.8 The Model EMC-25 Series of Interference Analyzers is designed for use in manual, semiautomatic, and automatic systems. It contains all of the features listed as required in section 2.8.7.

2.9 Recording and Monitoring Devices

2.9.1 The X-Y Recorder

An X-Y Recorder may be used in a automatic or semiautomatic measuring system to make permanent records of the spectrum swept by the receiver. These records should also contain calibration information. The Model EXY-125 is an X-Y recorder specifically designed to be used in conjunction with the EMC-25 series of receivers. However, any X-Y Recorder having the required speed, sensitivity and response ranges can be adapted for this use.

2.9.2 The Spectrum Analyzer

It is useful, when making semiautomatic measurements, or when appraising the results of automatic measurements, to be able to view a portion or all of a frequency range on an oscilloscope trace. By quickly previewing the responses in the range of frequencies to be recorded before an X-Y Plot is made, it is possible to determine any problem areas which may be encountered. It is a waste of time to make permanent records over a number of bands if it can be first determined that out of specification responses do exist which must be investigated and corrected before a final permanent record is made. Also, knowledge of the type and character of the responses to be encountered may influence the adjustment and setup of the system.

A spectrum analyzer may also be used to determine the exact character of a received response so that it may be described more fully on the permanent plot.

Typically, a spectrum analyzer for use with a voltage tuned receiver generates a sawtooth voltage to control the tuning of the receiver. This voltage may sweep an entire band of the receiver or any portion of the band. This same sawtooth voltage causes the horizontal deflection on the oscilloscope screen.

The output of the receiver is fed to the vertical deflection circuit of the analyzer. By varying sweep speeds, sweep segments, detector functions, bandwidths, etc. of the receiver-spectrum analyzer system, the frequency vs. amplitude response on the spectrum analyzers screen can be analyzed visually.

The Model SPD-125 is a spectrum display unit designed specifically to be used with the EMC-25. It is capable of presenting both linear and logarithmically detected displays of the full octave bands of the EMC-25, or of any small portion of any band. The amplitude, frequency and character of responses can be analyzed from the scope display.

2.9.3 Fully automated systems are available for use with the EMC-25 receiver. Such systems include automatic band switching, automatic antenna selection, automatic X-Y recording of any and all bands, integral narrowband/broadband calibration and integral spectrum display capability.

3.0 The Requirements of MIL-STD-826

One of the purposes of Air Force specification MIL-STD-826 is to eliminate some of the confusion which existed due to variations among the specifications previously used. MIL-STD-826 consolidates procedures and limits of the previous documents into one comprehensive specification.

By defining an orderly procedure for the updating of test procedures within the specification and by specifying the more advanced measurement procedures, MIL-STD-826 has encouraged the development and use of more efficient means of making EMI measurements.

4.0 Specifications and Features of EMC-25 Receivers as they apply to measurements according to MIL-STD-826.

4.1 General

Each instrument in the EMC-25 series is a voltage-tuned, accurately calibrated superheterodyne receiver covering the frequency range of 14 kHz to 1000 MHz in 15 bands. Each can be operated manually, or most of its functions controlled remotely. Therefore, it is ideally suited for automated and semiautomated measurements. Some of the more important EMC-25 specifications are listed below:

4.1.1 Frequency Range: The usable frequency range extends from 14 kHz to 1 GHz in 15 bands.

Each band provides a minimum of 2% overlap at each end with respect to adjacent bands.

4.1.2 Frequency Accuracy: Frequency accuracy is within plus or minus two percent of indicated frequency. (With FINE TUNE control at mid-rotation.)

4.1.3 Input Impedance: Input impedance is a nominal 50 ohms.

4.1.4 Voltage Accuracy: Two-terminal CW voltage measurements, referenced against the internal calibrator, are accurate within plus or minus 1.5 dB (top 20 dB of the scale).

4.1.5 Sensitivity and Bandwidth: Table 4-1 shows the sensitivity and bandwidth of the EMC-25 Interference Analyzer.

4.1.6 Spurious Rejection: Rejection to Image and IF, and other spurious frequencies typically exceeds 60 dB and is never worse than 45 dB throughout the entire 14 kHz to 1000 MHz range.

4.1.7 Voltage Range: The analyzer is capable of measuring signals as large as 1.0V RMS. Voltage ranges are obtained by means of a 20 dB per step attenuator. Overall front panel meter range is 60 dB. Front-end attenuation is inserted in all positions except the most sensitive.

4.1.8 Frequency Control: The analyzer is tunable over any single band by means of a front panel control or by the application of a suitable voltage to a front panel connector.

Frequency bands are switched by a single front panel control or optionally by means of a remotely controllable internal stepping motor. The remote band indication is accomplished by means of binary switch closures.

4.1.9 Detector Functions

4.1.9.1 Carrier: Responding to the RMS value of an unmodulated sinewave and having nominal 600 milliseconds charge and discharge times.

4.1.9.2 Quasi-Peak: As in CARRIER except nominal charge time is 1 millisecond and discharge time 600 milliseconds.

4.1.9.3 Peak: As in CARRIER except charge time is $<<1/BW$ and discharge time is sufficiently long to read an impulse of 10 PPS rep rate with less that 1 dB decrease in accuracy.

4.1.9.4 Slideback: A metered indication of the detector biasing required for aural extinction of signals.

TABLE 4-1

SENSITIVITY AND BANDWIDTH

BAND	FREQUENCY RANGE	BW (3 dB) NB (Nominal Bandwidths)	BW (3 dB) WB (Nominal Bandwidths)	SENSITIVITY (worst case) *CW (NB) (uV)	SENSITIVITY (worst case) *IMPULSE (WB) (Db/uV/MHz)
1	14.0 kHz-28.5 kHz	500 Hz	4 kHz	0.06	+39
2	28.5 kHz-59.0 kHz	500 Hz	4 kHz	0.06	+39
3	59.0 kHz-120 kHz	500 Hz	4 kHz	0.06	+39
4	120 kHz-240 kHz	500 Hz	4 kHz	0.06	+39
5	240 kHz-480 kHz	500 Hz	4 kHz	0.06	+39
6	.48 MHz-1.05 MHz	500 Hz	5 kHz	0.06	+39
7	1.05 MHz-2.30 MHz	500 Hz	5 kHz	0.06	+38
8	2.30 MHz-5.00 MHz	5 kHz	50 kHz	0.12	+22
9	5.00 MHz-11.0 MHz	5 kHz	50 kHz	0.12	+22
10	11.0 MHz-25 MHz	5 kHz	50 kHz	0.12	+22
11	24 MHz-49 MHz	50 kHz	500 kHz	0.80	+20
12	49 MHz-98 MHz	50 kHz	500 kHz	0.80	+20
13	98 MHz-210 MHz	50 kHz	500 kHz	0.80	+23
14	210 MHz-490 MHz	50 kHz	500 kHz	1.00	+24
15	490 MHz-1000 MHz	50 kHz	500 kHz	1.60	+32

*NOTE: Tangential Sensitivity -- defined as the internal noise level or as the input signal level required to raise the meter reading 3 dB above the instrument noise. Tangential Sensitivity level is at least 8 dB above minimum discernible signal (MDS). MDS is sometimes defined as being 0.5 dB above the noise level.

4.1.10 Outputs

4.1.10.1 Post-IF: 1.0 MV RMS nominal into 50 ohms.

4.1.10.2 PRE-IF: 50 uV RMS nominal into 50 ohms.

4.1.10.3 Video: 25 MV Peak nominal into 91 ohms.

4.1.10.4 Audio: 100 MW nominal into 600 ohms.

4.1.10.5 Recorder, external meter: 1 MA at 1500 ohms.

4.1.10.6 X-Y Plotting: Y-axis 0 to +1.5 VDC into 1.5K ohms ±1%. X-axis 0 to +1.4 VDC nominal into greater than 10K ohms.

4.1.11 Calibration: The instrument includes a built-in wideband calibration system.

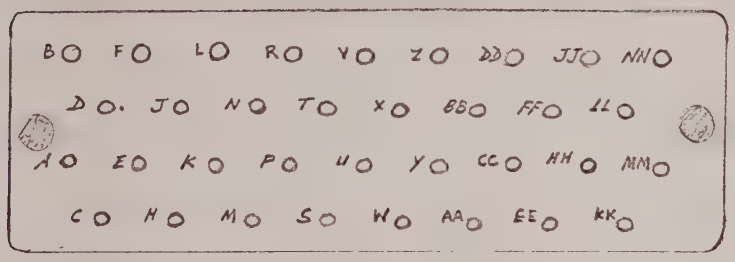
4.1.12 Power Requirements: The analyzer operates from 105V to 130V, or 210V to 260V, 50-450 Hz, as well as from its own internal battery supply, or from an external DC source.

Switching between internal supply and external supply is automatic when connected to external supply.

The EMC-25 is supplied with AC power cord, instruction manual, alignment tools and certificate of performance, DC power cord, battery pack, instrument carrying case, carrying cover with handle, adapter brackets, earphones, and control junction box.

4.2 Control Functions of the EMC-25

A. Remote Control Connector: All the remote functions of the EMC-25 are controlled by DC voltages or switch closures applied to the contacts of the multiple-pin remote connector located in the lower right-hand corner of the front panel. Remote frequency tuning, remote band selection, remote bandwidth selection, remote calibrator level adjust, remote band position indication, remote frequency indication, remote detector outputs and remote gain adjustments are included as a capability. For manual operation, a dummy plug must be connected to the remote connector. Figure 4-1 is a diagram of the pin locations of the remote connector and a listing of the remote functions performed by the various pins.



A	Tuning Pot Arm	V	X Out (0 to 1.5V)
B	Sweep In	W	Step Command (0 = OFF + 12V = STEP)
C	Tuning Voltage Input (0 to +1.5V nominal)	X	Shunt Cal Command (-Raw Activate)
D	Sweep Out	Y	IG Contacts (-300V to +300V for external level)
E	4-Band Logic	Z	IG Driver Command (-6V)
F	1-Band Logic	AA	Gain (0 to +12V)
H	8-Band Logic	BB	Dump Command
J	2-Band Logic	CC	Ground
K	AFC	DD	HV Raw
L	BW Selector Out	EE	+12V Command Functions Only
M	Band Logic Comm.	FF	Ground
N	BW Command (+12V = N. B. -6V = W. B.)	HH	Internal IG Level Switch
P	0.1NB COMMAND (+12V = 0.1NB; OPEN = NB, WB)	JJ	-6V Command Functions Only
R	Y Out (1 ma. 1500 ohms)	KK	+Raw Command Functions Only
S	NC X-Y Recorder Pen Lift	LL	Spare
T	Comm. X-Y Recorder Pen	MM	Spare
U	Audio Output	NN	-Raw Command Functions Only

Figure 4.1 Remote Connector (Outside View)

B. Frequency Tuning: Manual tuning is accomplished by means of the tuning control on the front panel. The frequency is indicated by the cursor on a slide-rule-type dial. Remote tuning is accomplished by feeding a voltage (from 0 volts to +1.5 volts DC) between pin C of the remote connector and ground (Pin FF). This remote tuning voltage may originate as a manual potentiometer adjustment or from a repetitive low-frequency sawtooth generator. Frequency calibration for remote tuning is accom-

plished by inserting signals of known frequency or by reading the frequency of a response on the tuning dial with the receiver operating in the manual tuning mode.

C. Bandswitching: Manual bandswitching is accomplished by means of a front panel control. The EMC-25R has remote bandswitching capabilities. A momentary connection between pins W and pin EE of the remote connector will step the bandswitch one position. In this manner, anyone of the 15 bands may be selected remotely. The position of the bandswitch is indicated remotely by a binary decimal code which can be obtained on Pins E, F, H, J and M (common). Besides being used as a remote band position indication, this band position information is used as a reference for automatic selection of the corresponding band in the remotely switched antennas (the RVR-25, RVA-25 and ALR-25). In the more automated systems, this information is also used for antenna and band selection.

D. Bandwidth Switching: The EMC-25 normally has two selectable bandwidths. For most of the measurements in MIL-STD-826A the wideband position of the bandwidth switch on the front panel is required. However, for spectrum analysis or maximum CW sensitivity, the narrowband position is more useful. In the narrowband position the bandwidth is about one-tenth that of wideband. The bandwidth may also be selected remotely. A connection between pin N and pin EE of the remote connector selects narrowband operation while a connection between pin N and pin JJ selects wideband operation. In the EMC-25N version, a third bandwidth is provided which is one-hundredth of the wide bandwidth. This optional extra-narrow bandwidth may also be selected remotely.

E. Detector Function Switch: This switch selects the various detector functions. It is a manual control only. For most MIL-STD-826 measurements this switch is positioned in "peak".

F. Attenuator Switch: An input level attenuator having 20 dB steps from 0 to 100 dB is a manual front panel control. The setting of this switch when algebraically added to the output meter reading of the receiver, indicates the level of the received response at the input terminals of the receiver. To amplitude-calibrate the receiver using the internal impulse generator, the attenuator switch must be in the CAL position. Each position of the attenuator switch is marked with two attenuator levels, one black and one orange. The black attenuator level markings apply when the bandswitch is in any position from Band #1 through Band #10. The frequency dial background color for these bands is white. The orange attenuator level markings are used for frequency bands #11 through #15. The frequency dial background color for these bands is orange.

G. Calibration Control: The control on the front panel labeled CAL is an IF gain control used in receiver calibration. The IF gain may also be controlled remotely by applying a voltage between Pin AA (positive) and Pin FF of the remote connector. Varying this applied voltage from 0 volts to +12 volts will vary the receiver gain from minimum to maximum.

H. Use of the Internal Impulse Generator: In manual operation, the fixed-level internal IG is activated and its output is internally connected to the input circuit of the EMC-25 whenever the SHUNT CAL button on the front panel is depressed. No external connections are needed. With the attenuator in CAL position and with the detector switch in PEAK, the CAL control is adjusted for a meter reading determined by the calibration chart of the instrument. The instrument is then calibrated in dB above one microvolt input, as determined by the meter reading and the attenuator setting. When the SERIES CAL button is pushed, the output of the internal IG is connected to the TNC connector

on the front panel labeled "IG OUT", where it may be used for series calibration. The internal IG may be operated remotely by making appropriate connections at the remote connector. The IG level may also be varied remotely. The Model CLC-25 Calibrator Level Control is an accessory which remotely controls the output of the internal IG so that it becomes a calibrated source having output levels variable from -15 dB/uV/MHz to +85 dB/uV/MHz in 1 dB steps.

I. Power Switch: The power switch turns the receiver on and off. Because the receiver operates from an internal battery, regardless of whether it is connected to an AC voltage source, this switch must be turned off whenever the instrument is not in use. Removal of AC power input will result in battery-only operation and eventual full discharge. If the battery becomes fully discharged, it should be charged by leaving the receiver plugged into a live AC outlet with the EMC-25 power toggle switch OFF for at least 16 hours to regain full charge. A fully-charged battery will operate the EMC-25 for at least 8 hours before requiring connection to AC power for re-charging.

J. Battery Test: To determine the condition of the internal battery, the red BAT TEST pushbutton on the front panel is depressed. If this lights up, the battery is sufficiently charged for proper EMC-25 operation.

K. Tuning Mode Switch: This small 3-position toggle switch on the front panel performs the following functions:

In MANUAL position, the receiver is tuned in a normal manner manually. In the AFC position, an automatic frequency control circuit in the receiver is activated and the tuning is locked on to received signal to facilitate long-term monitoring. In the SWEEP position, the receiver can no longer be tuned manually but it is electron-

ically swept-tuned over the frequency band whenever the sweep pushbutton switch is momentarily pushed to initiate a sweep. (Note: The tuning dial cursor does not respond to electronic tuning). This sweep is used in conjunction with an X-Y recorder to record the spectrum content for each band. The duration of this sweep is about one minute. For remote tuning functions this switch must be in the MANUAL position.

L. Dump Circuit: A peak-hold and discharge, or "dump" circuit is incorporated in the receiver design to make possible the automatic recording of various types of responses. As was noted previously, the peak detector decay time is normally very long, in order to permit the meter to display full response to short-duration pulse-type signals. If such a long decay time were used to make swept-frequency X-Y recordings, the response to a single signal in the frequency range would obscure other signals following it as the frequency range is swept. However, if a short decay time were utilized, a pulse-type signal might be recorded at reduced amplitude or not be recorded at all. The dump circuit of the receiver allows use of the long decay time needed to register full response to a single transient. However, after a period of time, dictated by the response time of the recording device, it is necessary to quickly "dump" the signal level stored in the detector so that additional responses can be recorded. The dump control on the front panel of the instrument controls the operation and dump time of this circuit. With this control fully counterclockwise, the dump circuit is disabled, and the peak detector operates normally. Turning this control slightly clockwise activates a switch which turns on the dump circuit. Further clockwise adjustment of the control shortens the dump time. If the dump time is set too short, improper amplitudes will be recorded, and if it is too long, nearby responses may be obliterated.

5.0 The SPD-125 Spectrum Display Module

5.1 General

The SPD-125 Spectrum Display Module consists of a basic oscilloscope frame (DuMont Type 767) utilizing a conventional time base plug-in unit (DuMont Type 74-14) for generating the horizontal linear sweep for the scope, and a special Y-axis plug-in unit (Fairchild/Electro-Metrics Model PP-125) that performs or controls the various functions required to present a swept frequency display on the oscilloscope.

The sawtooth waveform generated in the time base plug-in for horizontal deflection is used as a tuning voltage source for the EMC-25 receiver. The frequency of the EMC-25 is therefore swept at the same rate, and is synchronized with, the horizontal sweep of the scope. Output signals from the EMC-25 are processed by the Y-axis plug-in (Model PP-125) of the SPD-125 and presented on the scope trace. Logarithmically-detected spectrum responses are obtained by presenting the logarithmically detected signal output of the EMC-25 on the screen. Linear spectrum responses may also be viewed, as the Model PP-125 contains its own IF amplifiers and linear detectors to process the linear "Pre-IF" output of the EMC-25. The whole octave range band of the EMC-25 may be presented at one time, or any small portion of the band may be expanded to cover the entire scope face.

5.2 Interconnections to the Model SPD-125

A. A multiple-conductor cable, connected between the remote connector of the EMC-25 and a corresponding connector on the front panel of the PP-125 plug-in of the SPD-125 carries the required exchange of control information between the two units. Since it is usually required that other remotely controlled equipment also be connected to the remote connector of the EMC-25, the SPD-125 control cable is usually

connected to the EMC-25 by way of connector junction box Model CJB-25.

B. A coaxial cable, connected between the "AM Video" jack in the front panel of the EMC-25 and a correspondingly marked jack on the front panel of the PP-125 supplies the logarithmically detected output of the EMC-25 for logarithmic scope presentation.

C. A coaxial cable, connected between the Post IF output jack on the rear of the EMC-25 and a correspondingly marked jack on the front panel of the PP-125 supplies an undetected IF signal from the EMC-25 which is amplified and detected in the PP-125 plug-in to provide the linearly detected scope display.

5.3 Control Functions of the PP-125 Plug-in of the SPD-125

A. The positioning control on the PP-125 Plug-in provides a means of vertically positioning the scope trace.

B. A four-position function switch on the PP-125 controls the manner in which the EMC-25 is swept-tuned.

In the "Spectrum" position of this function switch the full, octave band of the EMC-25 is swept-tuned at a rate determined by the sweep-rate position of the time-base plug-in of the SPD-125. The scope display is a frequency-amplitude sweep of the band.

In the "Locator" position of the Function Switch, the display is the same, except a brightened marker appears on the trace which identifies the segment of the frequency band which will be swept in the next, or "Signature" position of the switch. The position of this marker is determined by the setting of the tuning dial cursor of the EMC-25, so that the marker can be used to determine the frequency of a response viewed on the scope. The length of the marker is changed by adjusting the setting of the "Dispersion" control of the PP-125.

In the "Signature" position of the function switch, that portion of the full octave sweep which was illuminated in "locator" position is displayed across the full face of the CRT. The frequency width of the spectrum swept is varied by adjustment of the "Dispersion" control.

In the "Video" position of the function switch, the display is a single-frequency time-amplitude presentation of the detected envelope modulation of any signal tuned in on the EMC-25. The signal displayed will be that appearing at the center of the CRT sweep in the "Signature" position. The function switch must always be kept in this "Video" position when manual frequency control is desired for the EMC-25, or when the EMC-25 tuning is to be controlled by any source other than the SPD-125.

C. Dispersion Control: The position of the dispersion control on the PP-125 controls the width of the frequency segment to be swept when the function switch is in "Signature" position. This band of frequencies can be varied from 10% down to 0.1% of whichever octave band is selected on the EMC-25.

D. Display Switch: In its "log" position, this two-position toggle switch causes the display to be presented in logarithmically-detected form. The amplitude of responses may be approximately determined by the right-hand calibration marks of the scope graticule, taking into account, of course, the RF input attenuator setting of the EMC-25.

In the "Linear" position of this display switch, a linearly-detected display is viewed on the scope. The relative amplitude of responses may be determined by the left-hand markings of the scope graticule.

E. The amplitude of the linear display on the scope may be varied over a 60 dB range through the use of the two 20 dB attenuator switches, together with the variable attenuator control on the PP-125. Therefore, any response visible on the logarithmically detected display (which covers an amplitude range of 60 dB) can be presented on the linearly detected display by adjusting these attenuator controls.

F. Video Filter: A low-pass filter is connected in the vertical deflection circuit when this switch is in its "On" position. This may reduce noise levels on the display to allow better surveillance of low-amplitude signals. This switch should be kept in its "Off" position unless needed for this purpose.

6.0 X-Y Recorder

6.1 General

The horizontal (X) pen position of the X-Y Plotter is controlled by the tuning voltage of the EMC-25. This position is, therefore, a positive indication of the frequency to which the EMC-25 is tuned. The vertical (Y) position of the pen is controlled by the same voltage (current) supplied to the front panel meter of the EMC-25. Whenever the tuning function switch of the EMC-25 is set to "Sweep," and the sweep button momentarily depressed, an internally generated ramp, or sweep voltage, which varies from 0V to 1.5V, sweeps the frequency to which the receiver is tuned from the low end of the band to the high end in about one minute. This sweep voltage, of course, also causes the horizontal position of the X-Y Plotters pen to move correspondingly.

6.2 X-Y Recorder Specifications for EMC-25 Usage

A. Input Impedance: The input impedance of both the X-Y channels should be 100K ohms or greater to prevent loading of the EMC-25's outputs.

B. Input Sensitivity: The sensitivity and offset adjustments of the recorder should be such that a change in input voltage of from 0V to +1.5V in either the X or Y inputs will cause a pen movement equal to the full respective plotting dimension of the plotting paper used.

C. Dynamic Accuracy: The pen travel should have a speed of at least 7 inches per second with negligible amplitude error. A slower pen response can cause inaccurate recording of signal.

C. Connection to the EMC-25 Receiver: The Y input signal for an X-Y recorder is obtained by connecting between pin R (Positive) and pin CC (Ground) of the remote

connector of the EMC-25. For correct calibration a 1500 ohm ± 1% load is required between these points. Normally, the use of a dummy plug, or the use of the SPD-125 Spectrum Display Module provides this load. The X input for the X-Y recorder is obtained by connecting between pin V (Positive) and pin CC (Ground) of the EMC-25's remote connector.

6.3 The Model EXY-125A Recorder

A. This recorder has an X input sensitivity variable from 50 to 300 mv/inch and Y input sensitivity variable from 75 to 400 mv/inch. It has a dynamic accuracy of ±0.2% at a pen speed of at least 7 inches per second.

B. Ink is supplied to the recorder's pen from a replaceable ink cartridge.

C. The power switch (Off-Standby-On) and the pen position switch ("Remote", "Pen Up", "Pen Down") are mounted through the top control panel of the recorder. The recorder adjustments "Y zero adjust", "X zero adjust", "Y gain control", "X course gain" and "X fine gain", are mounted below this panel. Access is obtained to these controls by lifting off the cover panel, which is retained in place magnetically.

D. A special plotting paper is required for use with the plotter. This paper which has the surface finish needed for reliable operation, and which includes a printed format and border, can be obtained from Fairchild/Electro-Metrics under the form number EMC-011.

6.3.1 Input Connections: The X and Y input signals from the EMC-25 are connected to an input terminal strip on the bottom surface of the recorder. Two different cables are made to connect the output circuit of the EMC-25 to the input of the recorder. Each of these cables is intended for specific application and they cannot be used interchangeably.

A. Model XYC-25 Plotter Cable is to be used when the recorder is to be the only termination on the remote connector for the EMC-25. This cable contains all of the various interconnections required for the operation of the EMC-25 when a dummy plug, or other termination, such as the SPD-125, is not used. This cable cannot be used in conjunction with the use of the SPD-125 or dummy plug.

B. Model XYC-25A Plotter Cable is used when other means are employed to provide the interconnections for remote operation of the EMC-25. A dummy plug or the SPD-125 (but not both) must also be connected to the remote connector circuit of the EMC-25, when this cable is used.

C. The fanning strip on one end of the required cable is connected to the terminal strip on the bottom of the recorder. The other end of the cable is connected to the remote connector on the front panel, either directly, or through the use of the Connector Junction Box, Model CJB-25.

7.0 Other Accessory Equipment

7.1 Connector Junction Box, Model CJB-25

This Junction Box is used whenever more than one piece of accessory equipment is to be connected to the remote connector of the EMC-25. The input to the box is through a short piece of cable terminated in a multi-pin plug which mates with the remote connector jack of the EMC-25. This cable is connected to the EMC-25 remote connector either directly or by means of the connector on the rear of the CLC-125 calibration level control. The output consists of three parallel-wired connectors mounted on the box. Two of these connectors are of the same type as the remote connector on the front panel of the EMC-25. The remote cable to the X-Y recorder, and/or the remote cable to the SPD-125 spectrum display module and/or the dummy plug may be connected here. The third connector is of the JAN type and is used for the remote band switching of antennas.

7.2 Impulse Generator Calibrator

7.2.1 The CLC-25 Impulse Generator Calibrator: The CLC-25 is an accessory piece of equipment which converts the fixed level internal impulse generator of the EMC-25 into a variable output calibrated impulse generator. When used, its input cable is always connected directly to the remote connector jack of the EMC-25. A connector on the rear of the CLC-25 is used to connect other accessory equipment to the EMC-25's remote circuit. If no other accessory equipment is used, the dummy plug must be inserted into this connector. Usually, however, the Connector Junction Box (CJB-25) is connected at this point.

The level switches on the CLC-25 provide calibration levels from -15 to +85 dB uV/MHz by varying the charging voltage applied to the internal impulse generator of

the EMC-25. A polarity switch allows either a positive or negative polarity impulse to be selected. In the "Off" position of this switch the CLC-25 is inoperative. However, normal use of the internal impulse generator can be accomplished only by disconnecting the CLC-25 from the circuit.

The impulse generator levels as indicated by the setting of the level switches of the CLC-25, is correct only with the EMC-25 attenuator set in its "CAL" position. When Shunt Calibration is used, correction factors must be applied for other attenuator settings. This is because the output of the internal impulse generator feeds directly into the input circuits of the EMC-25 receiver, by-passing the RF Input Attenuator. When using series operation, the correctly calibrated impulse generator level appears at the IG output connector, regardless of attenuator setting.

7.2.2 Use of an External Impulse Generator for Calibration: Any accurately calibrated 50 ohm impulse generator with a flat frequency response from 14 kHz to 1000 MHz, and having an adjustable output level from 0 dB uV/MHz to +100 dB uV/MHz can be used for calibration purposes in place of the CLC-25. However, the CLC-25 has an advantage in that calibration can be accomplished without disconnecting the input to the EMC-25. Most impulse generator manufacturers calibrate their instruments in terms of the rms sine-wave equivalent of the impulse generator's output over an impulse bandwidth of one MHz. This is the calibration required for MIL-STD-826A, and is the basis of calibration for the CLC-25. However, impulse generators manufactured by the Singer Company (Empire Devices) are calibrated in terms of the peak sine-wave equivalent of the impulse generator's output. To convert this peak calibration to the rms calibration required by MIL-STD-826A, 3 dB must be subtracted from the indicated output level.

7.3 Pickup Devices

7.3.1 Clamp-on Current Probe - Model PCL-25: This is a magnetic pickup device used to make conducted interference measurements over the frequency range of from 14 kHz to 100 MHz. It consists of a torroidal coil wound around a split and hinged ring core, which can be clamped around the conductor (or cable) on which measurements are to be made. Accurate conducted current measurements can be made in this manner without connecting to, or altering the circuit being measured. The torroidal construction makes the probe sensitive primarily to magnetic fields confined by the ring core, so that external magnetic fields, caused by currents flowing in near-by conductors have no significant effect on measurements.

7.3.2 Vertical Rod Antenna - Model RVA-25: This antenna is used for radiated interference measurements over the frequency range of 14 kHz to 25 MHz (Bands #1 through 10 of the EMC-25). It consists of a one-meter vertical rod (electrical length is 1/2 meter) with a ground plane. Matching transformers designed for optimum operation over each of the EMC-25's Receiver's frequency bands are remotely selected by the bandswitch of the EMC-25. A control cable (ACC-25) connected between the RVR-25 antenna and the remote connector of the EMC-25 feeds the band position information to the antenna to permit the automatic selection. A 25 ft. coaxial cable (CAC-25) connects the output of the antenna to the input of the EMC-25. An antenna factor chart is furnished with each antenna to convert the two-terminal output voltage of the antenna (as measured at the input of the EMC-25 Receiver) to the field strength of the signal intercepting the antenna. It is possible to use an equivalent antenna of other manufacture to make these measurements. However, since such an antenna cannot be switched remotely, and since its frequency bands probably would not correspond exactly to the EMC-25 Receiver's bands,

measurements would be more time-consuming.

7.3.3 Broadband Dipole Antenna - Model BDA-25: This antenna is used for radiated interference measurements over the frequency range of 25 MHz to 210 MHz (Bands #11, 12 and 13 of the EMC-25). It consists of a dipole antenna tuned to a center frequency of 120 MHz, and two sets of extension arms which change the center frequency to 60 MHz and 35 MHz. Large-diameter dipole elements and a broadband balun impedance matching transformer result in broadband reception and eliminate the need for intermediate length adjustments. The basic dipole, with no extensions used, covers a frequency range of 98 MHz to 210 MHz (Band #13). A single set of extensions added to the basic dipole results in a frequency range of from 49 MHz to 98 MHz (Band #12). When both sets of extensions are used, the frequency range becomes 25 MHz to 49 MHz (Band #11). An antenna factor chart is included with each antenna, to convert the two-terminal output voltage of the antenna to the field strength of the signal intercepted by the antenna. This antenna factor includes the insertion loss of the 25 ft. coaxial cable (CAC-25) used to connect the antenna to the input of the EMC-25. If a cable other than CAC-25 is used, the antenna factor must be corrected. An equivalent antenna of other manufacture can be used providing the frequency ranges covered are similar.

7.3.4 Log Conical Antenna - Model LCA-25: This antenna is used for radiated interference measurements over the frequency range of 210 MHz to 1000 MHz (Bands 14 and 15 of the EMC-25). It is a log conical spiral antenna constructed according to the requirements of MIL-STD-826A. By definition, it has an antenna factor of 12.5 dB over the frequency range. This antenna factor does not, however, include insertion losses in the 25 ft. coaxial cable CAC-25 used to connect the antenna to the EMC-25 Receiver. Figure 7-1 shows the antenna factor, including the insertion losses of the cable. If another

7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.

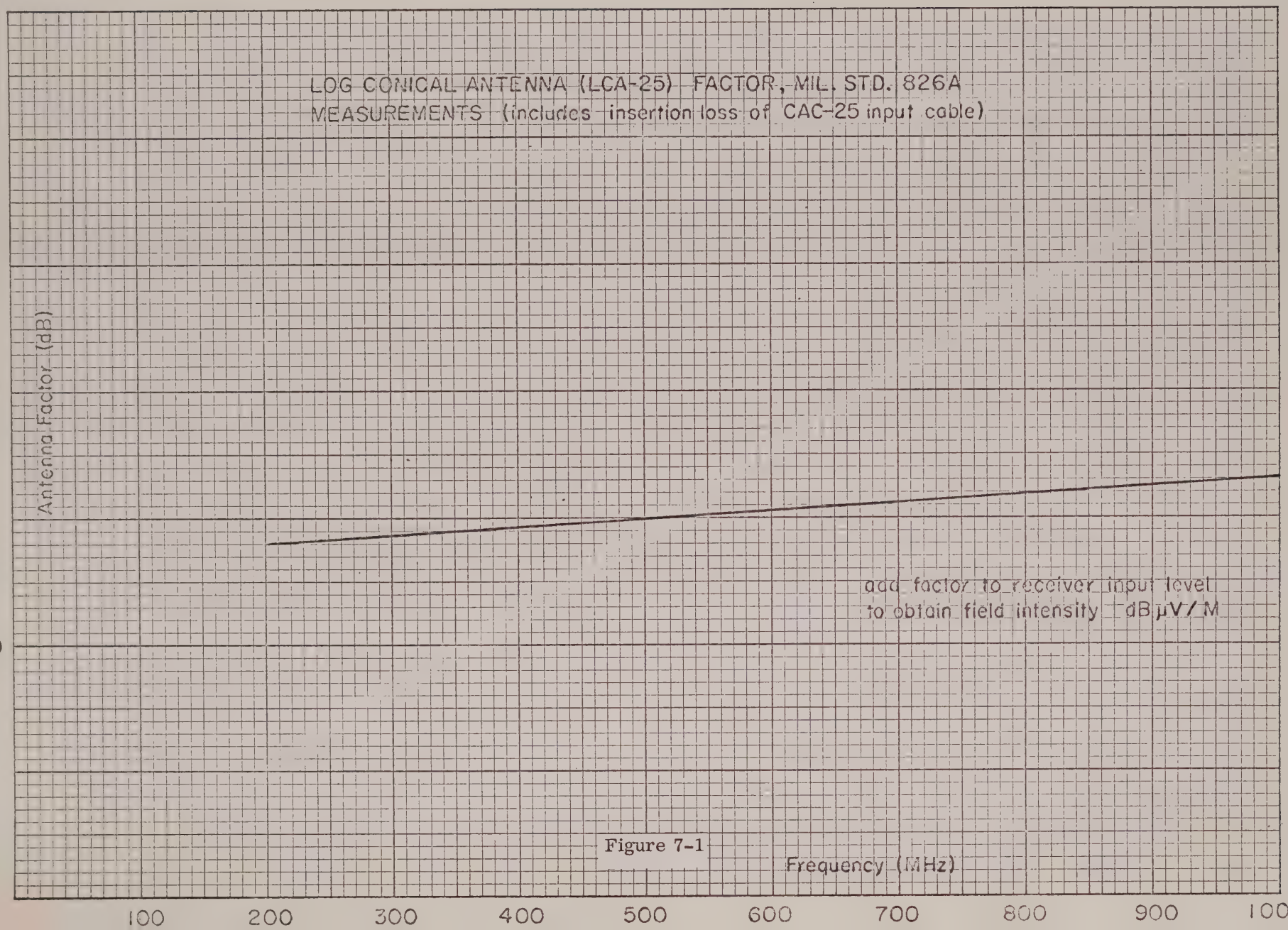


Figure 7-1

cable is used, its insertion loss must be established, and this loss added to the 12.5 dB antenna factor.

7.3.5 Insertion Losses of Signal Input Cables: The insertion loss of the signal input cables used must be considered to obtain accurate measurements. For all pickup devices described here, except for the log conical antenna, the cable loss for the Model CAC-25 coaxial input cable are included in the conversion factor. If another cable is used, having a different insertion loss, the conversion factor must be corrected by the difference between the loss of Cable CAC-25 and the loss of the cable used. Published information on the insertion losses of various lengths of various types of coaxial cable are quite accurate and may be used to determine the insertion loss of a cable which is correctly terminated. Figure 7-2 shows the typical insertion loss of the CAC-25 cable versus frequency. Actual insertion loss measurements at various frequencies can be made by feeding the input of a well-padded signal generator into the EMC-25 Receiver, tuning this signal in, establishing a reference reading in the EMC-25's meter, and then inserting the cable to be measured and noting the change in meter reading.

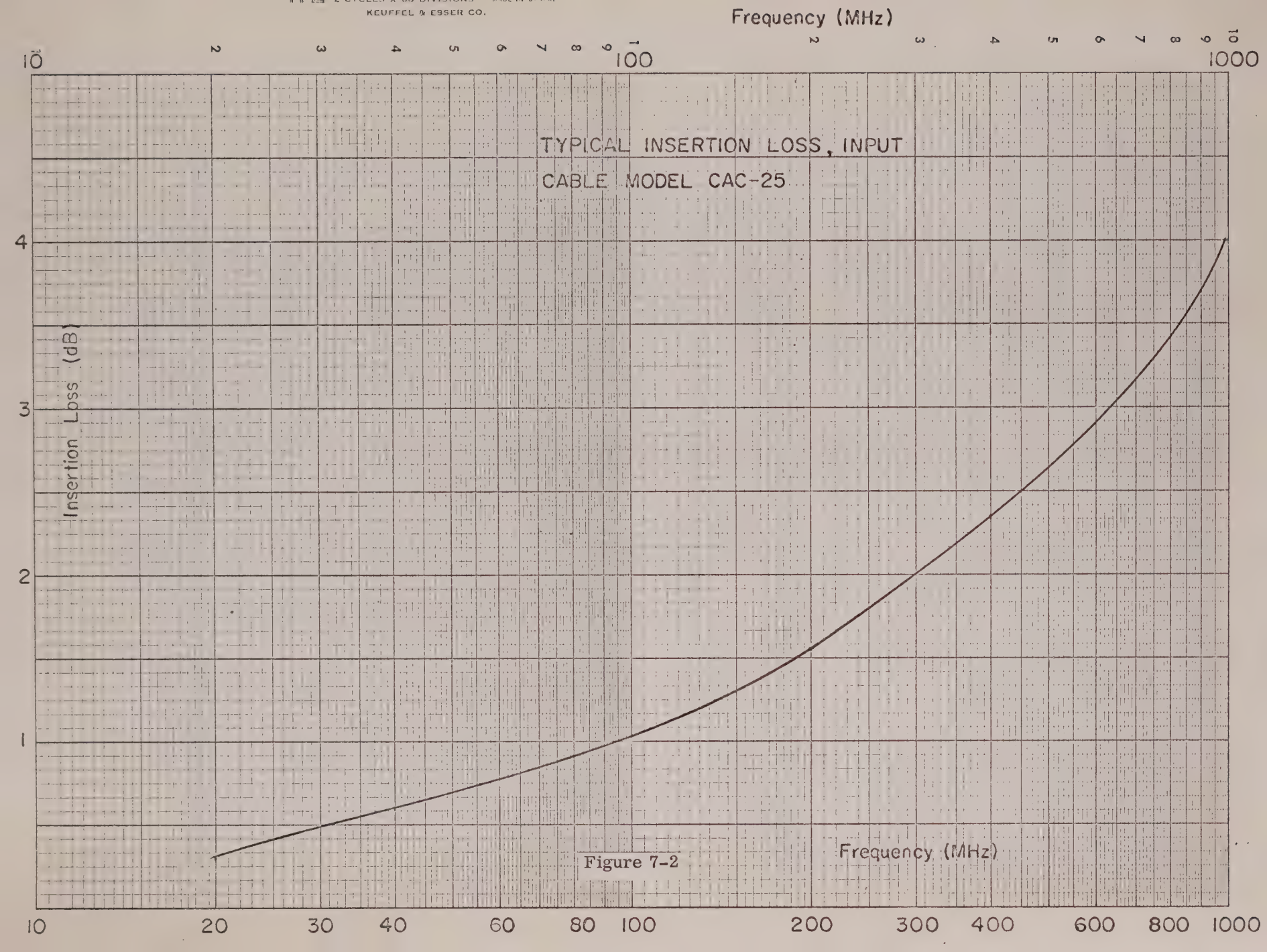

Frequency (MHz)
10
100
1000
TYPICAL INSERTION LOSS, INPUT
CABLE MODEL CAC-25
Insertion Loss (dB)
4
3
2
1
Frequency (MHz)
10
20
30
40
60
80
100
200
300
400
600
800
1000

Figure 7-2

8.0 Test Procedure: Conducted Interference Measurements

This Section describes in detail the step-by-step procedures to be followed when making broadband and narrowband conducted measurements according to MIL-STD-826A Method 3002, using semiautomated techniques. The procedures detailed here are in no way intended to modify the requirements of MIL-STD-826A. If a conflict should exist between this procedure and the requirements of MIL-STD-826A in any specific case, the requirements of MIL-STD-826 take precedence.

8.1 Test Equipment and Accessories Required

A. Interference Analyzer, EMC-25 or EMC-25R.

B. Calibrator, Model CLC-25 Calibrated Level Control, or external, calibrated impulse generator.

C. X-Y Recorder, Model EXY-125A or equivalent.

D. Spectrum Display Module, Model SPD-125.

E. Clamp-on Current Probe, Model PCL-25 or equivalent.

F. Connector Junction Box, Model CJB-25.

G. Interconnecting cables as follows:

1. From Junction Box to X-Y Recorder, Model XYC-25A or equivalent. (Multiple conductor).
2. From Current Probe to Interference Analyzer Input, Model CAC-25 or equivalent. (coaxial).
3. "SPD Control Cable", from Junction Box to Spectrum Display Module, Part #4657 or equivalent. (Multi-conductor).
4. "Post IF Cable", from Interference Analyzer (Post-IF output) to Spectrum Display Module, Part #4648-2, or equivalent.

5. "AM Video Cable", from Interference Analyzer (AM Video Output) to Spectrum Display Module, Part #4647-2, or equivalent.

8.2 Procedure for Making the Calibration Master Recordings to be Used for Test Measurement Evaluation

8.2.1 General

X-Y Recordings of the Conducted Interference characteristics of a test sample are to be made on plotting paper with calibration markings obtained by reproducing a previously-prepared Calibration Master Plot. A separate Calibration Master Plot is required for narrowband and broadband conducted measurements on each frequency band from 14 kHz to 100 MHz (Bands #1 through #12). Each calibration master is to contain frequency amplitude calibration lines. The test limit level as established by Fig. 1001-2 of MIL-STD-826A and adapted to the context of the calibration is plotted on each master.

8.2.2 Equipment Setup: Set up the measuring equipment in an approved shielded room as shown in Fig. 8-1, except that, if an external impulse generator is to be used for calibration purposes, the output of the impulse generator is connected to the RF input of the EMC-25. Since the same equipment setup is going to be used when making actual test measurements using the master plot now being made, and since ground loops cause error in the measurements, the manner in which the test equipment is arranged, especially the grounding of the equipments, should be noted and repeatable. Ideally, the test equipment is to be arranged in the same way that it will be for measurements on the variety of test samples for which it will be used.

The test equipment may be set up on the same ground-plane as will be used for making tests, if this is spacious enough to allow about three feet of separation from the

test sample. It is preferable, however, that the measuring equipment be set up on its own bench, at a location as far removed from the area in which the test samples are to be arranged as the limits of the room will permit. In either instance, the cases of the various pieces of test and auxiliary equipment should be insulated from each other, and from contact with the common ground of the shielded room. Rubber mats may be used to afford this ground isolation. The common ground connection between the various pieces of equipment is to be provided by the interconnecting cables. The only connection between the equipment and the common ground of the screen room is a ground strap to be connected from the ground strip at the rear bottom edge of the EMC-25 to the closest part of the ground-plane or wall of the shielded room. This ground strap should be as short as conditions permit.

The ground wire of the power cords of the measuring equipments involved should be isolated from ground through the use of ungrounded power plug adapters. The equipment may be rack mounted provided the case interconnections and grounding points provided by the rack mounting are both predictable and repeatable.

CAUTION: A short circuit in a piece of measuring equipment can cause a dangerous shock hazard if the case of the equipment becomes isolated from the ground. Therefore, the power cords of the equipments should not be plugged in until all the interconnecting cables are connected, and the EMC-25 grounding strap has been installed.

The interconnections are as follows:

a. Connect the attached multi-conductor of the CLC-25 to the remote connector jack on the front panel of the EMC-25. The Dummy plug is normally connected to this jack when the EMC-25 is being used without external accessory equipment, and may have to be removed.

b. Connect the attached multi-conductor cable of the CJB-25 Connector Junction Box to the multiple-pin jack on the rear of the CLC-25. If an external impulse generator is to be used instead of the CLC-25 Calibration Level Control, the input cable of the Connector Junction Box (CJB-25) is connected directly to the front panel remote connector of the EMC-25.

c. Connect the SPD Control Cable between one of the mating multiple-pin connector jacks of the CJB-25 and the multiple-pin connector on the front panel of the Y Plug-in)PP-125) of the Spectrum Display Module (SPD-125). If the SPD-125 is not to be used, the dummy plug which is supplied with the EMC-25 is to be connected to this plug of the Connector Junction Box (CJB-25).

d. Connect the X-Y Recorder Cable, Model XYC-25A to the remaining mating multi-pin connector of the CJB-25. Connect the fanning strip on the other end of this cable to the terminal strip on the bottom of the X-Y Recorder (EXY-125A). The recorder cable, Model XYC-25 cannot be used here, as it contains interconnections which are imcompatible with simultaneous use of the X-Y Recorder and the Spectrum Display Module.

NOTE: If, for any reason the system is to be operated without using the X-Y recorder connected, the multi-pin connector of the CJB-25 which would normally be used to make the connection to the recorder should be left vacant. (Do not use dummy plug here.)

e. Connect the AM-Video Cable between the AM-Video output connector on the front panel of the EMC-25 and the AM-Video input connector on the Y plug-in (PP-125) of the SPD-125.

f. Connect the Post-IF cable between the Post-IF output jack on the rear panel of the EMC-25, and the Post-IF input jack on the front panel of the PP-125 plug-in of the SPD-125.

g. Connect a grounding strap from the grounding strip on the rear, lower edge of the EMC-25, and bond the other end of this strap to the ground plane or wall of the shielded room. This ground strap should be as short as conditions permit.

h. If the CLC-25 Calibration Level Control is to be used, connect the RF input jack of the EMC-25 to the Clamp-on Current Probe (PCL-25) by means of the 25-foot TNC type coaxial cable, Model CAC-25. If an external impulse generator is to be used for calibration purposes, the output of the impulse generator is connected to the RF input of the EMC-25 by means of a short coaxial cable, for which it must be calibrated.

i. After all interconnections have been made, the power cords of the EMC-25, the SPD-125, and the X-Y recorder may be plugged in, using ground isolating adapters between each power cord and power receptacle.

8.2.3 Explanation of Tables #3002-1 and 3002-2: Before beginning the procedure for making the Master Calibration Charts for conducted measurements, the operator should check Table #3002-1 (Broadband Conducted Measurements) and Table #3002-2 (Narrowband Conducted Measurements) to determine if all the columns of these tables contain the required information. In order to insure accurate measurements, the electrical characteristics of the specific test equipments involved must be considered. To accomplish this, a number of the columns of Tables 3002-1 and 3002-2 have been left vacant, to be filled in by the operator with information pertinent to the specific units of test equipment to be used. To complete the information to be contained in the tables, the Broadband Correction Factor of the EMC-25 used and the Conversion Factor of the Clamp-on Probe used must be known.

In the following discussion, the information to be contained in each of the columns of Tables 3002-1 and 3002-2 is described, as well as the means of determining the values to be inserted in the blank columns.

A. Column A of both tables lists the EMC-25 frequency band setting.

B. Column B lists the frequency range covered by each band.

C. Column C lists three calibration frequencies in each band which will be used to fix calibration points on the finished master. Each band has a low frequency calibration point, a center frequency calibration point, and a high frequency calibration point.

D. The Broadband Conversion factors of the EMC-25 used are to be listed in Column D for each of the three calibration frequencies for each band. This conversion factor is obtained from the Calibration Chart which accompanies each EMC-25. The right-hand calibration markings of the Calibration Chart are used.

E. In Column E is to be listed the impulse generator level to be used to amplitude calibrate the EMC-25. For frequency bands #1 through #10, 20 dB is to be added to the broadband conversion factors listed in Column D to obtain the quantities to be included in Column E. This is because the "Cal" position of the EMC-25 Attenuator is the 20 dB position for these bands. For bands 11 and 12, 40 dB is to be added to the broadband conversion factor, as the "Cal" position of the attenuator for these bands is 40 dB. When the "Cal" control of the EMC-25 is adjusted for a 0 dB meter reading, with the impulse generator level given in column E at the input, the EMC-25 is calibrated as a two-terminal voltmeter. That is, the rms, CW equivalent of the peak signal level of an input signal at the calibration frequency can be determined directly from the Attenuator position and the meter reading.

F. The conversion factor at the Calibration frequencies for the current probe used is to be listed in Column F. This conversion factor is obtained from the conversion

chart that comes with the probe. The conversion factors given for the current probe PCL-25 have the units of dBuA/uV and this factor is listed directly. Other current probes may be calibrated in terms of transfer impedance (dBΩ). The sign of this transfer impedance quantity should be changed before the quantity is listed in Column F.

This is because: +dBΩ = +dBuV/uA = -dBuA/uV

G. The limit, as established by MIL-STD-826A at each of the Calibration Frequencies is listed in Column G. The Broadband Conducted Limit is listed in Table 3002-1, and the Narrowband Limit is listed in Table 3002-2.

H. The position in which the EMC-25 attenuator switch is to be set when making the Master Calibration Chart is listed in Column H. For bands #1 through band #10, the black attenuator markings are used. For bands #11 and 12, the orange attenuator markings are used.

I. The impulse generator level to be used to make the top calibration line of each Master Calibration Plot is listed in Column I. This level setting is to be used only when an external impulse generator is used. A total of five amplitude calibration lines are required for each Master. The lower four lines are spaced in 5 dB increments below this Top Line Level.

J. The impulse generator level to be used, as indicated by the level switch setting of the CLC-25 Calibrated Level Control, to make the top Calibration Line of each Master Calibration Plot is listed in Column J. This column is to be used instead of Column I when the CLC-25 is used for calibration purposes. It will be noted that the IG levels listed in Columns I and J are the same, when the EMC-25 attenuator setting, as listed in Column H is in Cal position. However, when this attenuator position is other than Cal, there is a difference in level settings between Columns I and J. This is because the output of the built-in impulse generator, whose level is controlled by the CLC-25, is

injected directly into the front end of the EMC-25, by-passing the input RF attenuator. To determine the effective impulse input level for a given setting of the CLC-25 level controls, the following correction factors may be used:

1) When the EMC-25 attenuator switch is set in its 0 dB position (20 dB orange markings), -6 dB is added to the level setting of the CLC-25 to determine the effective output of the impulse generator.

2) With the EMC-25 Attenuator in its Cal position (20 dB black markings or 40 dB orange markings), the output level as indicated by the level setting of the CLC-25 is the effective impulse generator output level.

3) In the 40 dB attenuator setting (60 dB for the orange markings) +10 dB is added to the level setting of the CLC-25 to obtain the effective impulse generator output.

4) For each additional 20 dB step on the EMC-25 attenuator, add 20 dB to the level established in (3) to determine the effective impulse generator level; that is, in the 60 dB position, 30 dB is to be added to the CLC-25 level setting, while in the 80 dB attenuator position, 50 dB is added.

K. In Column K of Tables 3002-1 and 3002-2 is to be listed by the operator the meter reading obtained at the center calibration frequency, when an impulse level as listed in Column I or J is inserted into the input of a correctly calibrated EMC-25. This reading is not required for making measurements, but is helpful in determining if the system is repeatable in its operation and calibration.

L. In Column L are to be listed the current levels at the input of the current probe, which are represented by the top calibration line, when the Input Attenuator of the EMC-25 is set in its measurement position, as listed in Column Q. Since the current level depends

on the Current Probe conversion factor (Column F), and also, for Narrowband measurements, on the Broadband Conversion Factor (Column D), the input current levels represented by the top calibration line will not be the same at all frequencies in the band. Therefore, this input current level is to be determined at each of the three calibration frequencies of each band. The manner in which these current levels are determined is different for Broadband and Narrowband measurements.

1) For Broadband measurements, the quantities to be listed in Column L of Table 3002-1 are determined as follows:

For each of the calibration frequencies of each band, add the "Current Probe Conversion Factor" (Column F) to the "Attenuator Setting for Measurement" (Column Q). To this total, add the "IG Input Level-Top Cal Line" (Column I). From this total, subtract the "Attenuator Setting-Master Plot" (Column H). This operation may be described algebraically as: $L = I + F + Q - H$, where the capital letters represent the Column headings of Table 3002-1. The unit of measurement for this column is dBuA/MHz.

2) For Narrowband measurements, the quantities to be listed in Column L of Table 3002-2 are determined as follows:

For each of the Calibration Frequencies of each band, add the "Current Probe Conversion Factor" (Column F) to the "Attenuator Setting for Measurement" (Column Q). Add to this the "IG Input Level-Top Line" (Column I). Now subtract from this total the "Broadband Conversion Factor" (Column D) and the "Atten. Setting-Master Plot" (Column H). This operation may be described algebraically as follows:

$L = I + F + Q - D - H$, where the capital letters represent the Column headings of Table 3002-2. The unit of measurement for quantities listed in Column L is dBuA.

M. In Column M are to be listed the Current Probe input levels represented by the second calibration line of the Calibration Master. Since the Calibration line is created with an impulse generator level which is 5 dB less than the Top Calibration Line, the input current levels to be listed in this column are 5 dB below the levels at the corresponding frequencies of Column L.

N. In Column N are listed the Current Probe input levels represented by the third calibration line of the Calibration Master. The current levels to be listed here are 10 dB below the level at the corresponding frequency listed in Column L.

O. In Column O are listed the Current Probe input levels represented by the fourth calibration line of the Calibration Master. The current levels to be listed in this column are 15 dB below the level of the Top Line Calibration Levels listed in Column L.

P. In Column P are listed the Current Probe input levels represented by the bottom calibration line of the Calibration Master. The current levels to be listed in this column are 20 dB below the levels listed in Column L.

Q. Column Q lists the attenuator position of the EMC-25 which is to be used when actual test measurements are made using the Calibration Master Plot.

8.2.4 Initial Control Settings: Set the controls of the measuring equipments involved to the settings listed below. These initial settings are used as a starting point for the following procedure. When a control setting has not been specifically changed by the procedure, it is assumed the settings are as listed.

A. EMC-25 Control Settings:

1) Band Switch----------Band #1

TABLE 3002-2

NARROWBAND CONDUCTED INTERFERENCE MEASUREMENT
MIL-STD-826A METHOD 3002

FREQUENCY			GENERAL CALIBRATION DATA				MASTER PLOT CALIBRATION DATA				CALIBRATION LINE EQUIV. CURRENT LEVELS					TEST
FREQUENCY BAND (EMC-25)	FREQUENCY RANGE	CALIBRATION FREQ.	BROADBAND CONV. FACTOR (EMC-25 CAL. CHART)	IMPULSE LEVEL-EMC-25 CAL. BANDS 1 TO 10, E=D+20 BANDS 11 & 12, E D-40	CURRENT PROBE FACTOR (PROBE CAL CHART)	NARROWBAND COND. LIMIT MIL-STD-826A	ATTENUATOR SETTING FOR MASTER PLOT	IMPULSE LEVEL TOP CAL. LINE	CLC-25 LEVEL SETTING TOP CAL. LINE	EMC 25 METER READING CENTERBAND FREQ.	TOP CALIBRATION LINE L=(F+I+Q)-(D+H)	SECOND CAL. LINE M=L-5	THIRD CAL. LINE N=L-10	FOURTH CAL. LINE O=L-15	BOTTOM CAL. LINE P=L-20	ATTENUATOR SETTING FOR TEST MEASUREMENT
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
	KHZ	KHZ	dBMHz	dBuV/MHz	dBuV/uA	dBuA	dB	dBuV/MHz	dBuV/MHz		dBuV	dBuA	dBuA	dBuA	dBuA	dB
1	14	14	+42	+62	+20	70	20 (CAL)	80	80	+18	+78	+73	+68	+63	+58	40
	↓	22	42	62	16.5	64					74.5	69.5	64.5	59.5	54.5	
	30	30	42	62	15	61					73	68	63	58	53	
2	30	30	42.5	62.5	15	61	20 (CAL)	78	78	+12	70.5	65.5	60.5	55.5	50.5	40
	↓	45	42.5	62.5	10.5	56					66	61	56	51	46	
	60	60	42.5	62.5	8.0	52					63.5	58.5	53.5	48.5	43.5	
3	60	60	42.5	62.5	8.0	52	40	94	84	+12	59.5	54.5	49.5	44.5	39.5	40
	↓	90	42	62	4.5	46					56.0	51	46	41	36	
	120	120	42	62	2.0	43					53.5	48.5	43.5	38.5	33.5	
	120	120	41	61	+2	43					50	45	40	35	30	

4	250	250	40.5	60	-3	35					46	41	36	31	26		
5	250 ↓ 500	250 400 500	43 42 42	63 62 62	-3 -5.5 -6.5	35 29 26.5	40	86	76	+3	40 38.5 37.5	35 33.5 33.5	30 28.5 27.5	25 23.5 23.5	20 18.5 18.5	40	
	MHz	MHz															
6	.50 .80 1.10	.50 .80 1.10	43.5 44 42.5	63.5 64 62.5	-6.5 -9 -10	26.5 20 17	20 (CAL)	83	83	+9	33 30 30.5	28 25 25.5	23 20 20.5	18 15 15.5	13 10 10.5	20 (CAL)	
7	1.1 ↓ 2.4	1.1 1.8 2.4	42 43 42	62 63 62	-10 -11 -11.5	17 11 10	20 (CAL)	75	75	+12	23 21 20.5	18 16 15.5	13 11 10.5	8 6 5.5	+3 +1 +.5	20 (CAL)	
8	2.4 ↓ 5.0	2.5 4.0 5.0	25.5 24 24	45.5 44 44	-11.5 -12 -12	10 10 10	40	75	65	+11	18 19 19	13 14 14	8 9 9	+3 +4 +4	-2 -1 -1	20 (CAL)	
9	5.0 ↓ 11.0	5.0 9.0 11.0	23 23 25	43 43 45	-12 -12 -12	10 10 10	40	75	65	+12	20 20 18	15 15 13	10 10 8	+5 +5 +3	0 0 -2	20 (CAL)	
10	11 ↓ 25	11 19 25	21 22 23	41 42 43	-12 -12 -12	10 10 10	40	75	65	+13	22 21 20	17 16 15	12 11 10	+7 +6 +5	+2 +1 0	20 (CAL)	
11	25 ↓ 50	25 40 50	+4 +2 +2	44 42 42	-12 -12 -12	10 10 10	40* (CAL)	54	54	+12	18 25 20	13 15 15	8 10 10	+3 +5 +5	-2 0 0	20	*
12	50 ↓ 100	50 80 100	+3 +3 +3	43 43 43	-12 -12 -12	10 10 10	40* CAL	54	54	+11	19 19 19	14 14 14	9 9 9	+4 +4 +4	-1 -1 -1	20	*

* ORANGE MARKINGS

SAMPLE TABLE 3002-2

VALUES SHOWN ARE ONLY TYPICAL. OPERATOR MUST COMPLETE TABLE 3002-2. USING "BROADBAND CONVERSION FACTOR" (EMC 25) AND "CURRENT PROBE FACTOR" OF THE EQUIPMENT TO BE USED.

2) Frequency Tuning ---------- Lowest Frequency Position (Against mechanical stops)

3) Input Attenuator ---------- 20 dB (Cal) Position

4) Fine-Tuning Control ---------- Center Range (Dot up)

5) Tuning Mode Switch ---------- Manual

6) Tuning Aid ---------- Off

7) Dump Control ---------- Off (Fully Counterclockwise)

8) Detector Function Switch ---------- Peak

9) Bandwidth Switch ---------- Wide

10) Cal. Control ---------- Center of range

11) Audio Control ---------- Fully Counterclockwise

12) Power Switch ---------- On

B. SPD-125 Spectrum Display Module Control Settings:

1) PP-125 Settings (Y Plug-In)

a. Dispersion Control ---------- Fully CCW

b. Attenuator Switches ---------- Both in 20 dB position

c. Attenuator Control ---------- Fully CCW

d. Display Switch ---------- Log Position

e. Video Filter Switch ---------- Off

f. Function Switch ---------- Video

g. Position Control ---------- As required

2) Time Base Plug-in (Type 74-14) Control Settings:

a. Synch Source ---------- Line

b. Synch Coupling ---------- AC

c. Synch Slope ---------- +

d. Synch Level ---------- Auto (Fully CW)

e. Sweep ---------- Normal

f. Sweep Speed ---------- 50ms/cm

g. Variable Sweep ---------- Cal (Fully CW)

h. Position ---------- As required

3) Main Frame (SPD-125) Control Settings:

a. Power Switch ---------- On

b. Intensity, Astigmatism, and Focus Controls ------- As required

C. Calibration Level Control (CLC-25) Settings:

1) Polarity Switch ---------- + position

2) Output Level Switches ---------- to be set later

8.2.5 Plotting Paper

Only the paper type which is recommended by the Manufacturer should be used for making the Master Calibration Plot. Use of other paper may result in inking skips, clogged pens, and errors due to excessive pen friction.

Paper for use with the EXY-125A Recorder may be obtained from Fairchild Electro-Metrics. A plotting paper with a printed format (like Fig. 8-2) may be obtained by ordering form #EMC-011. This paper has a printed border to contain the plotting area and to be used for the initial calibration of the X-Y Recorder. It also contains room for including such information as the test equipment used and test conditions. Blank recording paper can be obtained by ordering Part # EMC-012. This blank paper should be used to make reproduction of the completed Master Calibration Plot. If a

recorder of a different make is to be used, or if printed-border format paper is not available, a border area, similar to the border of the paper shown in Fig. 8-2 should be drawn, printed, or reproduced on the paper which is to be used for the Master.

8.2.6 Calibration Adjustments for the X-Y Recorder

A. Place a piece of scrap plotting paper on the recorder's plotting surface. Manually drop the pen to the paper, and move the pen carriage across it, noting if the pen writes with a clear, even weight. If the ink does not flow evenly, the ink supply may have to be replaced, or the pen may need cleaning.

B. Now place a piece of clean plotting paper, containing a printed-border area, as described in Section 8.3.5 on the plotting surface of the recorder. Position the paper carefully in about the horizontal center of the plotting area, with the lower edge of the paper located uniformly against the lower paper guide of the recorder.

C. Turn the Power switch of the EMC-25 OFF. Turn the Power switch of the Recorder to its OPERATE position. Adjust the Y-ZERO adjustment of the Recorder until the pen is positioned vertically over the bottom border line of the paper. (It may be necessary to move the paper horizontally to determine this pen setting.

D. Turn the Power switch of the EMC-25 to ON. Insert an impulse generator signal into the RF input of the EMC-25. This can be done either by holding in the SHUNT CAL button of the EMC-25, if the CLC-25 Calibration Level Control is used, or by feeding the output of an external impulse generator into the RF input connector of the EMC-25. Adjust the level of the impulse generator, and the CAL control of the EMC-25, until a full scale (+20 dB) reading is obtained on the front panel meter of the EMC-25. Now, while maintaining a full-scale meter reading, adjust the Y-Gain control of the Recorder until the pen is positioned over the top border line of the plotting

paper. If the Y Zero or Y Gain controls were badly misadjusted, it may be necessary to repeat these adjustment procedures to overcome control interaction.

E. Check to make sure that the EMC-25 tuning control is against the mechanical stops at the low frequency end of the dial. Now position the plotting paper horizontally, until the pen is positioned over the left-hand border line of the paper. It may be convenient, or necessary, to adjust the X Zero adjustment, if the paper position required is too far off center.

F. Adjust the frequency control of the EMC-25 so that the frequency indicating dial is against the mechanical stops at the extreme high frequency end of the band. Adjust the X Gain controls (COURSE AND FINE) so that the pen is positioned over the right-hand border line of the plotting paper. The pen position at the low frequency end of the dial should again be checked and any required adjustments made to overcome control interaction.

8.2.7 SPD-125 Adjustments

The Spectrum Display Module is not used in this procedure for making the Master Calibration Plot. It is connected into the circuit, plugged in, turned on, and adjusted to the typical settings listed in Section 8.3.4 so that the conditions existing when the calibration plots are made duplicate the conditions which will be encountered when measurements are made using these Plots.

8.2.8 Frequency Calibration of the Master Calibration Plot

A. It is assumed the plotting paper has been positioned in the X-Y Recorder, and the system has been calibrated according to Section 8.3.6. The bandswitch is positioned on the correct band.

B. It is convenient if the plotter pen is positioned close to the bottom border line

during this procedure. This can be done by removing the impulse generator input, turning the EMC-25 DETECTOR FUNCTION switch to CARRIER, and turning the CAL control fully CCW.

C. Adjust the TUNING control of the EMC-25 until the frequency dial cursor indicates the lowest frequency numerical calibration line of the dial. Mark the horizontal position of the X-Y plotter's pen either by manually dropping the pen to the paper, or by making a light pencil mark on the plotting paper. Next to this point, lightly indicate in pencil the frequency this point represents.

D. Repeat this procedure for each numerical calibration line of the EMC-25's frequency dial. In each case, the TUNING control is adjusted to indicate the next higher frequency numerical calibration line of the dial, the point is marked on the plotting paper, and the indicated frequency is lightly noted.

8.2.9 Amplitude Calibration of the Master Calibration Plot

A. General

Amplitude calibration lines are now to be drawn on the plotting paper, using an impulse generator. To avoid confusion, separate Master Calibration Masters are to be made for Broadband and Narrowband Measurements. The procedure for making each of these masters is identical, since only the attenuator setting of the EMC-25 and the impulse generator levels used are different. Table 3002-1 contains the required information for making the Broadband Calibration Master, and Table 3002-2 contains this information for making the Narrowband Calibration Master. In the following procedure these tables will be referred to as Table 3002-( ). It is assumed that the operator will use the table corresponding to the measurement for which he wishes to make the Master Calibration Chart. A separate set of Calibration Masters is required for each frequency band.

In the following step-by-step procedure it is generally assumed that the CLC-25 Calibrator Level Control is being used for calibration purposes. If an external impulse generator is used for calibration purposes, the operator should understand, that when he is directed to push in the SHUNT-CAL button of the EMC-25, he should, instead, feed the output of the external impulse generator into the RF input jack of the EMC-25.

B. Amplitude Calibration of the EMC-25: On each band, prior to making the amplitude calibration lines, the EMC-25 is to be calibrated using the following procedure:

1) Set the controls of the EMC-25 according to Section 8.3.4.

2) Set the EMC-25 TUNING control to the center-band Calibration Frequency listed in Column C of Table 3002-( ). Set the Level Controls of the CLC-25 Calibrator to the level listed for this frequency in Column E. Hold in the SHUNT-CAL button of the EMC-25. Adjust the CAL control for a reading of 0 dB on the front panel meter.

3) The EMC-25 is now calibrated in terms of dBuV (rms) for a CW input signal. The CAL control should not be moved again during the remainder of the calibration procedure on this band. If this control is inadvertently changed, the above calibration procedure should be repeated before continuing.

C. Adjust the Attenuator setting of the EMC-25 to the position listed in Column H of Table 3002-( ). If the CLC-25 is being used as the impulse generator calibrator, set the level switches of this unit to the value listed in Column J. If an external impulse generator is used as the calibrator, set its output to the level noted in Column I.

D. Depress and hold in the SHUNT-CAL button of the EMC-25. Note the indication on the front panel meter of the EMC-25. This reading should be the same as is listed in Column K of 3002-( ). If Master calibration charts have not previously been made on this band, it is possible no meter reading has been included in Column K. If this is the

case, the present meter reading should be entered in the column. This reading is intended to give the operator a reference level to determine if the equipment is correctly aligned and operating.

E. Place the TUNING FUNCTION switch of the EMC-25 in its SWEEP position. Press and hold in the SWEEP button. At the same time, hold in the SHUNT CAL button. Wait until the pen of the Recorder has come to a stable position near the left-hand border of the paper, then lower the Plotter's pen by placing the Pen Position switch of the Recorder in its DOWN position. Release the SWEEP button, but keep the SHUNT CAL button depressed.

F. The pen of the recorder will now move slowly across the plotting area of the paper, inking a line as it moves. This line is the Top Calibration line of the Master. When the pen reaches the right-hand border line of the paper, raise the plotter's pen by placing the PEN POSITION switch of the Recorder in its PEN UP position, and release the SHUNT CAL button of the EMC-25.

G. The Second Calibration line is next drawn. This is done by reducing the output level of the impulse generator calibrator by 5 dB, then holding in both the SWEEP button and SHUNT CAL button of the EMC-25 until the Recorder's pen has moved to the left-hand border. Then lower the pen to the paper by placing the Pen Position switch in DOWN and release the SWEEP button, while keeping the SHUNT CAL button depressed. Raise the plotter's pen when it reaches the right-hand border of the paper.

H. The Third, Fourth, and Fifth (Bottom) Calibration lines are now drawn in turn in the same manner. The impulse generator input level is reduced in 5 dB steps for each line.

I. Next record a line which represents the ambient noise level of the receiver. This line is recorded in the same manner as those above, except no impulse generator

is used. Instead, the current probe is attached to the input of the receiver. The current probe is not to be clamped around a conductor.

J. The partially completed Master Calibration Plot is now removed from the Recorder, and the final preparatory steps are to be completed.

8.2.10 Final Preparation of the Master Calibration Plot

A. Draw, in pencil, the vertical Frequency Calibration lines on the Master Plot. This is done by drawing straight lines between the upper and lower border lines of the paper, perpendicular to the top edge of the paper, and intersecting each of the frequency calibration points which had been previously plotted. Clearly mark the frequency each of these lines represents in the bottom margin of the paper.

Put an asterisk next to the frequency calibrations which correspond to the lowest, center-band, and highest calibration frequencies as noted in Column C of 3002-( ), so that these frequencies may be easily identified.

B. Put a heavy dot at the intersection point of the Frequency Calibration line corresponding to the lowest Calibration Frequency (Column C) and each of the five amplitude calibration lines. Lightly label each of these points with the input current level they represent, as determined by Columns L, M, N, O and P of Table 3002-( ).

C. Similarly, mark and label the center-band Calibration Frequency input current levels for the five Amplitude Calibration lines, and the highest-Calibration Frequency input levels for these Calibration Lines.

D. Determine the MIL-STD-826A (Method 3002) limit level for the lowest Calibration Frequency by referring to Column G of Table 3002-( ). Plot this point on the Frequency-Amplitude grid formed by the frequency and amplitude calibration lines. The space between the Amplitude Calibration lines is to be interpolated linearly.

E. Similarly, plot the center-band Calibration Frequency and the highest Calibration Frequency limit levels as determined from Column G.

F. Draw a smooth curve through the three limit points just plotted. The curvature of this line should generally conform to the shape of the amplitude calibration lines, and it should extend from the left-hand border to the right-hand border of the paper. Clearly label the three plotted points on this line with the current limit levels they represent (Column G), and indicate the unit of measurement. In the case of the Broadband Master Cal Plot, this unit will be dBuA/MHz. For the Narrowband plot this unit is dBuA. Clearly label the plotted line "LIMIT LEVEL". The limit level line should be darker and heavier than the other calibration lines.

G. Permanently label the current amplitude level of each of the calibration points on the amplitude calibration lines. (These points had previously been temporarily identified). Omit any of these markings which might cause confusion with the limit level line.

H. All of the specific information required by the operator to make a test measurement using a copy of this Calibration Master should be included on it, so that, once the operator is familiar with the general measurement procedure, he can make measurements using only the information contained on the Master. Figure 8-2 shows a typical completed Master Plot. The information to be included on each Master is as follows:

1) The frequency band covered, the bandwidth classification of the measurement, the type of measurement and the MIL-STD-826A Method used should all be included in the upper margin of the plot.

2) The model and serial numbers of the measuring equipments used to make the Master should be included in the lower left-hand margin of the plot.

14KHz to 30KHz

8/6/68 McConnell

FREQUENCY IN ____

PAGE ____

Company ____

Program ____

Test No. ____

Test Specimen ____

Date ____

Conducted By ____

Test Spec. ____

Section ____

Scan Speed ____

Bandwidth ____

TEST EQUIPMENT

FSS-250, S.N. ____

EMC-25 S.N. 26

X4C-25 S.N. 129

CAC-25 S.N. 102

CLC-25 S.N. 35

SPD-125 S.N. 69

FAIRCHILD ELECTRO-METRICS CORPORATION AMESBURY, MASSACHUSETTS

Form EMC-011 1/3/68

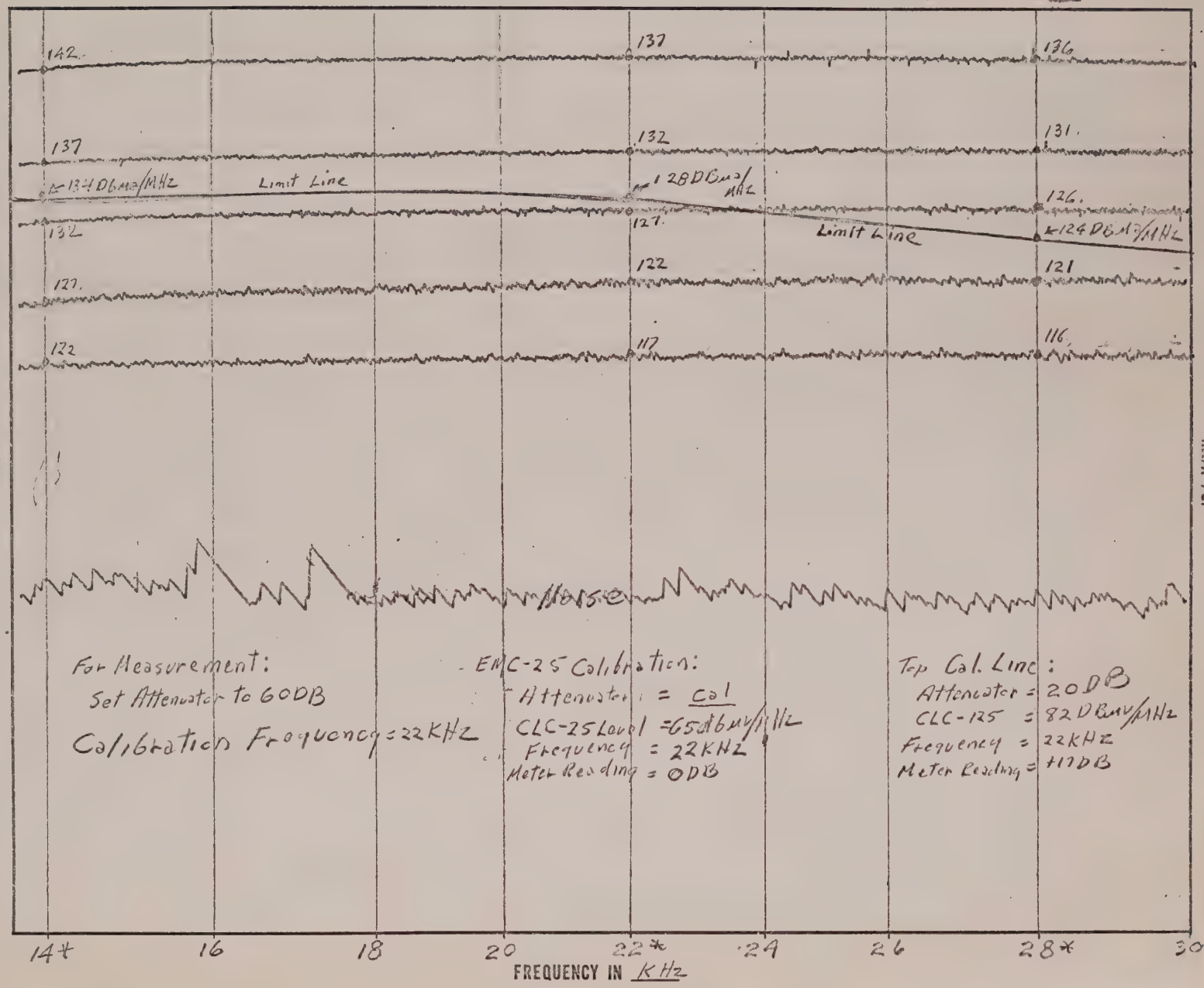


Figure 8-2

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TABLE 3002-1

BROADBAND CONDUCTED INTERFERENCE MEASUREMENT
MIL-STD-826A METHOD 3002

FREQUENCY			GENERAL CALIBRATION DATA				MASTER PLOT CALIBRATION DATA				CALIBRATION LINE EQUIV. CURRENT LEVELS					TEST
FREQUENCY BAND (EMC-25)	FREQUENCY RANGE	CALIBRATION FREQ.	BROADBAND CONV. FACTOR (EMC 25 CAL CHART)	IMPULSE LEVEL-EMC 25 CAL BANDS 1 TO 10, E=D+20 BANDS 11 & 12, E=D+40	CURRENT PROBE FACTOR (PROBE CAL CHART)	BROADBAND COND. LIMIT MIL-STD-826A	MASTER PLOT ATTENUATOR SETTING	IMPULSE LEVEL TOP CAL LINE	CLC-25 LEVEL SETTING TOP CAL LINE	EMC-25 METER READING CENTER BAND FREQ.	TOP CALIBRATION LINE (L=I+F+Q-H)	SECOND CAL LINE (M=L-5)	THIRD CAL LINE (N=L-10)	FOURTH CAL LINE (O=L-15)	BOTTOM CAL LINE (P=L-20)	TEST MEASUREMENT ATTENUATOR SETTING
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
	kHz	kHz	dBMHz	dBμV/MHz	dBμV/μA	dBμA/MHz	dB	dBμV/MHz	dBμV/MHz	dBμV	dBμA/MHz	dBμA/MHz	dBμA/MHz	dBμV/MHz	dBμA/MHz	dB
1	14 ↓ 30	14 22 30				134 128 124	20 (CAL)	80	80							60
2	30 ↓ 60	30 45 60				124 120 116	20 (CAL)	80	80							60
3	60 ↓ 120	60 90 120				116 111 106	20 (CAL)	77	77							60
4	120	120 200				106 98	40	90	80							60

	.50	250					93									
5	.50 ↓ 5.0	250 400 500					93 84 79	20 (CAL)	80	80						40
	MHz	MHz														
6	.50 ↓ 1.10	.50 .80 1.10					79 69 62.5	40	90	80						40
7	1.1 ↓ 2.4	1.1 1.8 2.4					62.5 52 50	20 (CAL)	77	77						20
8	2.4 ↓ 5.0	2.5 4.0 5.0					50 50 50	40	72	62						40
9	5.0 ↓ 11.0	5.0 9.0 11.0					50 50 50	40	72	62						40
10	11 ↓ 25	11 19 25					50 50 50	40	72	62						40
11	25 ↓ 50	25 40 50					50 50 50	60*	72	62						60*
12	50 ↓ 100	50 80 100					50 50 50	60*	72	62						60*

* ORANGE MARKINGS

TABLE 3002-1

TABLE 3002-2

NARROWBAND CONDUCTED INTERFERENCE MEASUREMENT
MIL-STD-826A METHOD 3002

FREQUENCY			GENERAL CALIBRATION DATA				MASTER PLOT CALIBRATION DATA				CALIBRATION LINE EQUIV. CURRENT LEVELS					TEST
FREQUENCY BAND (EMC-25)	FREQUENCY RANGE	CALIBRATION FREQ.	BROADBAND CONV. FACTOR (EMC-25 CAL. CHART)	IMPULSE LEVEL- EMC-25 CAL. BANDS 1 TO 10, E=D+20. BANDS 11 & 12, E D+40	CURRENT PROBE FACTOR (PROBE CAL- CHART)	NARROWBAND COND. LIMIT MIL-STD-826A	ATTENUATOR SETTING FOR MASTER PLOT	IMPULSE LEVEL TOP CAL. LINE	CLC-25 LEVEL SETTING TOP CAL. LINE	EMC 25 METER READING CENTERBAND FREQ.	TOP CALIBRATION LINE (L=(F+I+Q)-(D+H)	SECOND CAL. LINE M= L-5	THIRD CAL. LINE N= L-10	FOURTH CAL. LINE O= L-15	BOTTOM CAL. LINE P= L-20	ATTENUATOR SETTING FOR TEST MEASUREMENT
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
	KHZ	KHZ	dBMHz	dBuV/MHZ	dBuV/uA	dBuA	dB	dBuV/MHz	dBuV/MHz		dBuV	dBuA	dBuA	dBuA	dBuA	dB
1	14 ↓ 30	14 22 30				70 64 61	20 (CAL)	80	80							40
2	30 ↓ 60	30 45 60				61 56 52	20 (CAL)	78	78							40
3	60 ↓ 120	60 90 120				52 46 43	40	94	84							40
4	120	120 200				43 38	40	89	79							40

	250	250				35										
5	250 ↓ 500	250 400 500				35 29 26.5	40	86	76							40
	MHz	MHz														
6	.50 1.10	.50 .80 1.10				26.5 20 17	20 (CAL)	83	83							20 (CAL)
7	1.1 ↓ 2.4	1.1 1.8 2.4				17 11 10	20 (CAL)	75	75							20 (CAL)
8	2.4 ↓ 5.0	2.5 4.0 5.0				10 10 10	40	75	65							20 (CAL)
9	5.0 ↓ 11.0	5.0 9.0 11.0				10 10 10	40	75	65							20 (CAL)
10	11 ↓ 25	11 19 25				10 10 10	40	75	65							20 (CAL)
11	25 ↓ 50	25 40 50				10 10 10	40* (CAL)	54	54							20*
12	50 ↓ 100	50 80 100				10 10 10	40* CAL	54	54							20*

* ORANGE MARKINGS

TABLE 3002-2

3) The EMC-25 Attenuator setting required to make a measurement (Column Q of Table 3002-( ) is needed. This can be noted in the lower left-hand plot area. Since other MIL-STD-826A Methods may require different settings of the DETECTOR FUNCTION and BANDWIDTH switches of the EMC-25, it is helpful if the correct settings for these controls is also included here.

4) EMC-25 calibration data should also be presented. This information should include ATTENUATOR setting (CAL), the frequency (center-band CAL frequency of Column C) and the impulse generator level (Column E). This may be noted in the lower central region of the plot area.

5) It is helpful, in determining if the system is correctly adjusted and operating, if the conditions required to cause the X-Y plotter's pen to be positioned over the top calibration line of the Master are stated. This requires the noting of the ATTENUATOR position (Column H), the impulse generator level (Column I or J) and the EMC-25 meter reading (Column K) at the center-band calibration frequency. This information may be included in the lower right-hand portion of the plot area.

6) Space should be reserved in the upper left-hand margin of the plotting paper so that information concerning the test sample measurements made using copies from the Master can be entered.

7) The date, the operator's name, and other filing identification should be included.

8.2.11 Master Plots Required

Calibration Master Plots for Narrowband and for Broadband conducted measurements on each frequency band from Band #1 through Band #12 are to be made using the preceding procedure.

8.2.12 Use of Master Plots

The finished Calibration Masters are to be reproduced, and the copies are to be used for making test sample measurements. Once a set of Masters is completed, copies can be made and used for a long period of time providing the same equipment used to make the Masters is used for the measurements, and providing the equipment is calibrated and functioning correctly. Most equipment malfunctions will become evident during the prescribed calibration procedure required prior to making test measurements. If permanent changes occur in the system due to the substitution of equipments, or major repairs, the accuracy of the Masters can be checked by calibrating the equipment according to the preceding section, and comparing calibration lines on a copy of the Master during dummy runs. If it is determined that the Masters are no longer accurate, new Masters must be made, the old Masters must be marked "Obsolete", and all copies of the old Master destroyed.

8.2.13 Reproduction of the Master Calibration Plots

The Masters are to be reproduced on the type of plotting paper recommended for use with the X-Y plotter employed. Blank plotting paper for use with the EXY-125A recorder may be obtained under part #EMC-012. Any reproduction means which does not require sensitized paper, and which affords reasonable registration can be used. The Xerox type of reproduction is ideal for this application, since faithful reproductions can be made on the required paper at low cost for relatively few reproductions. If a large number of copies are needed, photographic printing processes can be used.

8.3 Conducted Interference Measurement, Setup and Adjustment

8.3.1 Test Sample Setup

Set up the equipment in a shielded room as shown in Figure 8-3. The test sample is set up on a copper or brass ground plane which is bonded to the wall of the shielded

room. This equipment is to be arranged to as closely simulate the actual normal operating conditions as possible. Any parts which would normally be grounded are to be bonded to the ground plane, but any parts which would not be grounded under normal operation are not to be connected to the ground plane. A 10 microfarad low-inductance low-power-factor feed-thru capacitor is connected between each input power lead and the ground plane. If the power is normally supplied to the equipment through a cable, these leads are to be separated from this cable, and each power lead brought out individually to its own feed-thru capacitor. Provision is to be made so that the current probe may be clamped around each individual power lead, between the feed-thru capacitor and the input to the equipment under test. The output leads of power producing equipment such as generators, alternators, converters, etc. are likewise to be brought to individual by-pass capacitors. Neutral and external ground leads associated with the power input or output of the equipment under test are to be separated so that the current probe can be clamped around each individually. Wires and cables other than those associated with the power input or power output of the equipment under test are not to be connected to 10 microfarad capacitors, but are to be terminated with their normal loads.

All the electrical and mechanical loading which will exist in the normal operation of the equipment is to be duplicated as far as possible for this test. The equipment is to be adjusted in such a manner as to create conditions which are most likely to generate maximum interference during normal conditions. Measurements are not normally required to be performed on leads interconnecting individual components of the test sample.

8.3.2 Measuring Equipment Setup

Set up the measuring equipment as shown in Figure 8-1.

The interconnections are as follows:

A. Remove the dummy plug from the remote connector jack in the front panel

of the EMC-25 Interference Analyzer and connect the attached multi-conductor cable of the CLC-25 Calibration Level Control to this jack.

B. Connect the input cable of the CJB-25 Connector Junction Box to the multiple-pin jack of the CLC-25. If an external impulse generator is to be used instead of the CLC-25, connect the input cable of the CJB-25 directly to the remote connector of the EMC-25.

C. Connect the SPD Control Cable between one of the multiple-pin connector jacks of the Connector Box (CJB-25) and the multiple-pin input jack on the front panel of the Y plug-in (PP-125) of the Spectrum Display Module (SPD-125). If the SPD-125 is not to be used, the dummy plug which is supplied with the EMC-25 must be connected to the multiple-pin jack of the Connector Box.

D. Connect the X-Y Recorder Cable (XYC-25A) to the other multiple-pin connector of the Connector Junction Box (CJB-25). The Recorder Cable (XYC-25) must not be used for this purpose, as it contains jumpers which are incompatible with the use of the SPD-125. Connect the fanning strip on the other end of the Recorder Cable XYC-25A to the terminal strip on the bottom of the X-Y Recorder Model EXY-125A. If an X-Y Recorder is not to be used in the setup, but the Spectrum Analyzer Module (SPD-125) is used, leave the second multiple-pin connector of the Connection Junction Box open. Do not connect the EMC-25 Dummy Plug here, as its functions are performed by the SPD-125's circuitry. If the Spectrum Display Module (SPD-125) is not to be used, the dummy plug must be connected to one of the multiple-pin connector jacks of the Connector Junction Box (CJB-25).

E. Connect the AM Video Cable between the AM Video Connector jack on the front panel of the Interference Analyzer (EMC-25) and the AM Video input jack on the front

panel of the Y Plug-in (PP-125) of the Spectrum Display Module.

F. Connect the Post IF Cable between the Post IF output jack on the rear of the Interference Analyzer (EMC-25) and the Post IF input jack on the front panel of the Y Plug-in (PP-125) of the Spectrum Display Module (SPD-125).

G. Connect a bonding strap from the bonding strip across the lower rear edge of the Interference Analyzer (EMC-25) to the ground plane or wall of the screen room used.

H. Connect the signal input coaxial cable CAC-25, a twenty-five foot cable with TNC connectors, between the RF input jack of the EMC-25 and the TNC connector on the Clamp-on Probe (PCL-25).

I. Now the power cords of the EMC-25, the SPD-125, and the X-Y Recorder may be plugged into outlet sockets in the screen room. Ground isolating adapters must be used between each power plug and outlet socket so that the ground pin of the power cords is left floating.

J. This setup should exactly duplicate the arrangement used when the Master Calibration Plots were made, especially as far as the equipment grounding is concerned. If space permits, the measuring equipment may be set up on the same ground plane as the equipment under test, the measuring equipment spaced at least three feet from the equipment under test. It is preferable, however, that the equipment be set up on its own bench, at a point far displaced from the equipment under test as the confines of the screen room permit. In either instance, the cases of the several pieces of measurement equipment involved should be insulated from contact with the ground plane, or contact with each other. Rubber mats may be used between the ground plane and the equipments,

or between the equipments when they are stacked. It is permissible, however, to rack-mount the measuring equipment provided this arrangement was used when the Master Calibration Plots were made, and providing that the resultant interconnection between the equipment cases, and between the equipment cases and the ground of the screen room is reliably reproducible. The bonding strap between the EMC-25's border, strip, and the screen room's ground is to be the only external connection for the measuring equipment. The other equipments are grounded by means of their interconnecting cables.

CAUTION: Internal shorts within the equipments involved can result in a shock hazard if the equipments are plugged in before other interconnections are made.

8.3.3 Initial Control Settings

Set the controls on the measuring equipments involved to the settings listed below. These initial settings are used as a starting point for the following procedure. When a control setting has not been specifically changed by the procedure, it is to be assumed the settings are as listed.

A. EMC-25 Interference Analyzer Control Settings

1) Bandswitch ---------- Band number 1.

2) Frequency Tuning Dial ---------- Lowest frequency position. (Against mechanical stops)

3) Input Attenuator ---------- 20 dB (CAL) position.

4) Fine Tuning Control ----------Center range (Dot Up)

5) Tuning Mode Switch ---------- Manual

6) Tuning Aid ---------- Off

7) Dump ---------- Off (Fully Counterclockwise)

8) Detector Function----------Peak

9) Bandwidth----------Wide

10) Cal.----------Center Range

11) Audio----------Fully CCW

12) Power----------On

B. SPD-125 Spectrum Display Module Control Settings

1) PP-125 (Vertical Deflection Plug-In)

a. Dispersion Control----------Full Clockwise

b. Attenuator Switches----------Both 20 dB

c. Attenuator Control----------Full CCW

d. Display Switch----------Log

e. Video Filter Switch----------Off

f. Function Switch----------Video

g. Position----------As required

2) Time Base Plug-In (74-14)

a. Source----------Line

b. Coupling----------AC

c. Slope----------+

d. Level----------Auto (Full CW)

e. Sweep----------Norm

f. Sweep Speed----------50ms/cm

g. Variable Sweep----------Cal (Fully CW)

h. Position----------As required

3) Main Frame (Scope)

a. Power Switch ---------- Power On

b. Intensity, Astigmatism, and Focus ------- Adjust for clear scope trace.

C. Calibration Level Control

1) Polarity Switch ---------- + position

2) Output Level Switches ---------- As noted

D. EXY-125 Control Positions

1) Power Switch ---------- Standby

2) Pen Position ----------Pen Up

3) X Gain ----------To be adjusted later.

4) Y Gain ----------To be adjusted later.

8.3.4 Gain and Zero Adjustments for the X-Y Recorder

A. Place a piece of scrap plotting paper on the plotting surface of the X-Y Recorder. Manually drop the pen to the paper and move the pen carriage across the paper, noting if the pen writes with a clear even weight. If the ink does not flow evenly, the ink supply may have to be replaced, or the pen may have to be cleaned.

B. With the equipment settings as noted in 8.3.3, place a copy of the Master Calibration Chart corresponding to the Test Method (Method 3002), the frequency band, and the interference type (narrowband or broadband) to be covered in the test on the recording surface of the X-Y recorder. Position the paper in about the horizontal center of the recording surface, with the lower edge of the paper against the lower paper guide of the recorder.

C. Turn the power switch of the EMC-25 to OFF, and turn the power switch of the X-Y Recorder to ON. Adjust the Y Zero adjustment of the Recorder until the verti-

cal pen position corresponds with the bottom border line of the Master. It may be necessary to move the paper horizontally so that the pen can be positioned over this bottom line.

D. Turn the power switch of the EMC-25 to ON. Insert an impulse generator input to the EMC-25. This is done either by holding in the SHUNT CAL button of the EMC-25, if the CLC-25 calibrator is used, or by connecting the output of an external signal generator to the RF input of the EMC-25. Adjust the level of the impulse generator input and the CAL control of the EMC-25 until a full scale (+20 dB) reading is obtained on the front panel meter of the EMC-25. Now, with the EMC-25 meter reading full scale, adjust the Y Gain control of the X-Y Recorder until the pen position corresponds to the top border line of the calibration master. The impulse generator is now removed. If the Y Zero and Gain controls were badly misadjusted, it may be necessary to repeat these adjustments until any interaction between them is overcome.

E. Check to be sure that the tuning of the EMC-25 is at the extreme low frequency end of the dial. Now position the calibration plot paper horizontally, until the pen is positioned over the left-hand border line of the paper.

F. Turn the frequency control of the EMC-25 clockwise, until it is tuned to the extreme upper frequency and against the mechanical stop. Now adjust the X Gain controls (Course and Fine) until the Recorder's pen is positioned over the right-hand border line of the paper.

G. Return the EMC-25 tuning to the extreme low frequency end of the dial, and recheck the pen position. If it is not over the left-hand border of the paper, adjust the X Zero control of the Recorder until it is. Now return the power switch of the Recorder to Standby.

H. The X-Y Recorder has now been adjusted so that the plotting area corresponds to the area covered when the Calibration Master was made. For measurements using other masters and other bands or test methods, this adjustment should hold, as long as the plotting area is the same. However, since the various copying techniques used may result in size or registration differences between the various masters, it may be necessary to check these adjustments for each new master.

8.3.5 Amplitude Calibration of the EMC-25

This calibration procedure is to be performed on each frequency band prior to making measurements. The initial control settings should be as listed in Section 8.4.3.

A. Set the Bandswitch of the EMC-25 to the frequency band on which measurements are to be made. Adjust the tuning control until the center-band calibration frequency for the band used, as noted in Column C of Table 3002-1 or 3002-2 is indicated on the frequency dial of the EMC-25.

B. Determine the calibration impulse level required for this frequency by referring to Column E of Table 3002-1 or 3002-2. Set the controls of the impulse generator calibrator used for an output of this level. Feed the output of the impulse generator to the RF input of the EMC-25. Where the CLC-25 is used as the calibrator, this is done by holding depressed the SHUNT CAL button of the EMC-25. Now adjust the CAL control of the EMC-25 for a 0 dB meter reading on the front panel meter.

C. This calibration reproduces the calibration setting used when the Master Calibration plot was made for this band. It also allows the input level to the EMC-25 to be determined by the meter reading. Further, it allows the amplitudes of responses at this frequency viewed on a properly calibrated Spectrum Display Module (SPD-125) to be determined.

8.3.6 Adjustment of the Spectrum Display Module (SPD-125)

The initial control settings for the system should be as listed in Section 8.4.3.

A. Turn the scale illumination control of the scope until the scale markings are clearly visible. Adjust the intensity, focus, and astigmatism controls for a bright, clear trace. If no trace is visible, adjust the Y positioning control of the PP-125 Spectrum Display plug-in until it becomes visible. Adjust the X positioning control on the Time Base plug-in until the horizontal sweep is symmetrically positioned within the CRT'S graticule.

B. Turn the Function switch on the Spectrum Display plug-in to its "Locator" position, and tune the EMC-25 for a frequency dial indication of 22 kHz (Band #1). The contrast between the bright "Locator" segment and the dimmer trace should be clearly visible, but the dimmer portion of the trace should also be clear. If this is not so, re-adjust the intensity control and adjust the Contrast, a screwdriver control on the front panel of the Spectrum Display plug-in, as needed.

C. Turn the Function switch of the Spectrum Display plug-in to its "video" position. Note the peak noise level reading that is indicated on the front panel meter of the EMC-25. Carefully adjust the Y positioning control on the Spectrum Display plug-in so that the peak noise pulses visible on the scope trace have the same level as noted on the EMC-25 meter reading, as determined by the amplitude calibration markings on the right-hand border of the scope graticule.

D. Determine the Calibration Impulse level for this frequency (22 kHz), from Column E of Table 3002-1 or 3002-2. Set the impulse generator calibrator to this level,

and inject this into the RF input of the EMC-25. If the CAL control of the EMC-25 is properly set, the EMC-25 meter reading will be 0 dB. Readjust the CAL control if necessary. The top of the impulse generator spikes which are visible on the scope trace should also indicate a level of 0 dB, as determined by the right-hand calibration of the graticule. If this is not the case, adjust the Log Gain control, a screwdriver adjustment on the front panel of the Spectrum Display plug-in. Now adjust the output level of the impulse generator up and down in 10 dB steps, and note if the EMC-25 meter reading, and the top of the impulse generator spikes, as viewed on the scope, continue to agree approximately in amplitude level. A slight readjustment of the Y positioning control, and the Log Gain control may be needed for best correlation between these amplitude indications. Once this adjustment is made, reasonably accurate amplitude measurements can be made on all of the frequency bands by using the Spectrum Display Module.

8.4 Measurements Required per MIL-STD-826A Method 3002

The conducted interference on all input and output power leads, including external ground and neutral leads, is to be measured. Broadband and narrowband measurements are to be made on each individual wire over the frequency range of from 14 kHz to 100 kHz.

The conducted interference on signal and control leads to other equipments is also to be measured.

8.5 Initial Spectrum Surveillance

Much test time may be saved if each of the conductors on which test measurements are required is scanned quickly using the Spectrum Display Module, before

test measurements are recorded on the X-Y plotter. Trouble areas can be quickly identified, the conducted interference at these points determined, and if out-of-limit signal levels are detected, a decision made whether the test should proceed before corrective action is taken. As a general guideline, if conducted interference level 10 dB above the specified limit are noted, the test should be stopped, and corrective action taken.

8.5.1 Frequency Scanning Using the SPD-125 (Broadband)

The procedure for using the Spectrum Display Module to search for out-of-spec Broadband Conducted Interference signals is as follows:

A. Set the system controls according to Section 8.4.3 and calibrate the system according to Sections 8.4.5 and 8.4.6 on frequency band 1.

B. Set the function switch of the Spectrum Display plug-in to "Spectrum". Set the Attenuator of the EMC-25 to the position listed in Column Q of Table 3002-1 (Broadband Conducted Measurements).

C. Note and record the reference peak noise level as it is viewed on the oscilloscope trace of the scope. A grease pencil may be used to trace this peak noise level on the screen of the scope.

D. Next set the Attenuator of the EMC-25 to the position noted in Column Q of Table 3002-2 (Narrowband Conducted Interference). Note the reference peak noise level. This level may also be traced and identified on the screen of the scope.

E. Clamp the Current Probe PCL-25 around the first of the conductors of the test sample on which measurements are to be made. Set the Attenuator (EMC-25) to the position for broadband measurements (Column Q of Table 3002-1).

F. Carefully study the oscilloscope trace of the SPD-125. If no conducted interference higher than the ambient noise level of the measuring equipment is present, this level, as viewed on the scope will be the same as the reference noise level noted for broadband measurements. If conducted interference is present on the conductor being measured, all, or a part of the oscilloscope trace may be raised above the noted reference noise level, or moving spikes or stationary pips may be observed above the noise level, depending on the amplitude and character of the interference present.

8.5.2 Interpretation of the SPD-125 Display

The amplitude of any conducted interference signal must now be compared to the limit level, as established by MIL-STD-826A Method 3002 for broadband signals. An approximate determination of the relationship between the limit level, and the level of the response viewed on the CRT can be obtained as follows:

A. Study the Master Calibration Chart used for making X-Y recordings for this particular frequency band (Band #1), (Method 3002) and interference classification (Broadband in this case). For a properly calibrated system the reference noise level as plotted on the Calibration Master is the same as the peak reference noise level noted on the scope, and the signal amplitude represented by the top border line of the Calibration Master is the same as the amplitude represented by the top line of the oscilloscope's graticule. Therefore, the proportional relationship between the distance from the reference noise level and the top line of the Master, and the distance between the reference noise level and the limit line, as plotted on the Master, will be the same on the oscilloscope presentation. That is, if the limit level as plotted on the Master is approximately 2/3 of the distance between the reference noise level and

the top border of the Master, then a received interference signal on the scope which approaches an amplitude equivalent to 2/3 of the distance between the peak reference noise level noted on the scope, and the top graticule line of the scope, is approaching the limit level in amplitude. If a response is close to, or obviously exceeds the limit, more precise measurements are required to determine the signal amplitude and classification (broadband or narrowband).

It should be noted that for all frequency bands except 5, 6, and 7, any signal which is out-of-spec according to this broadband measurement is out-of-spec regardless of the classification (whether broadband or narrowband) of the signal. Section 8.5.4 describes the method to be used to determine the bandwidth classification of the signal.

8.5.3 Frequency Scanning for Narrowband Responses

After making a record of all out-of-limit signals for the broadband measurement, the band should next be scanned to determine if any signals exceed the narrowband limits. This is done by setting the EMC-25's Attenuator to the position noted in Column Q of the Narrowband Calibration Table (3002-2) and carefully observing the oscilloscope trace to note any change from the peak narrowband reference noise level noted earlier. The narrowband limit line on the scope may be approximately determined in the same manner that the broadband limit was determined in Section 8.5.2, using the Narrowband Calibration Master Plot for this frequency band.

8.5.4 Bandwidth Determination of Responses

If out-of-limit signals are noted, and if these signals were not determined to be out-of-limits during the broadband measurement, the bandwidth character of the signal must be established to determine if the response is an in-limit broadband signal, or an out-of-limit narrowband signal. The procedure for establishing the bandwidth charac-

teristics of the received signal is as follows:

A. Turn the function switch of the SPD-125 to its "Locator" position. Adjust the tuning knob of the EMC-25 until the brightened "Locator" portion of the scope trace is centered around the highest amplitude portion of the out-of-limit signal. (If several out-of-limit responses have been noted, start at the lowest frequency signal.)

B. Turn the function switch of the SPD-125 to "Video". Carefully tune the EMC-25 for a maximum indication on its front panel meter. Note this meter reading.

C. Now turn the bandwidth switch of the EMC-25 to its narrow position. Again carefully Fine-Tune the EMC-25 for a maximum meter indication and note this reading. Determine the difference between the narrowband bandwidth and wideband bandwidth readings of the meter.

D. Inject the output of an impulse generator into the RF input of the EMC-25, (if the CLC-25 is used, hold in the SHUNT CAL button) and adjust the impulse generator output level until the EMC-25 front panel meter reads approximately the same as the level noted for the narrowband bandwidth reading of the signal being analyzed. If the impulse generator output is not sufficient for this, set the impulse generator for its maximum level. Note the meter reading.

E. Now return the bandwidth switch of the EMC-25 to its "Wide" position and with the same impulse generator input, note the new meter reading. Determine the difference in meter readings for the two impulse generator bandwidth measurements. The impulse generator may now be removed from the RF input.(Reconnect the current probe, if it was disconnected to use an external impulse generator.)

F. If the change in meter reading caused when the EMC-25 bandwidth was

switched while receiving the test signal, is within 2 dB of the change in meter reading when the bandwidth was switched, while receiving the impulse input, the received signal is to be classified as broadband and the broadband limits are to apply. The results of this test mean that the spectrum of the received signal is at least as wide as two times the 3 dB wideband bandwidth of the EMC-25 receiver on this band.

G. If the difference in the change in meter reading for the above case is greater than 2 dB, the signal is to be classified as narrowband, and the narrowband limits are to apply. Such a result means that the spectrum of the received signal has a bandwidth which is less than two times the 3 dB wideband bandwidth of the EMC-25 receiver on this band. If little or no change in meter reading occurs when the bandwidth switch is changed, it means that the spectrum of the received signal is narrow, compared to the narrowband bandwidth of the EMC-25 receiver.

Example #1

Meter Reading, Signal input, wide bandwidth = +6 dB

Meter Reading, Signal input, narrow bandwidth = +2 dB

Signal Input Meter Reading Difference 4 dB

Meter Reading, Impulse input wide bandwidth = +6 dB

Meter Reading, Impulse input narrow bandwidth = -4 dB

Impulse Input Meter Reading Difference 10 dB

Since the signal input meter reading difference (4 dB) is not within 2 dB of the impulse input meter reading difference (10 dB), the signal is to be classified as narrowband, and narrowband limits are to apply.

Example #2

Meter Reading, Signal input, wide bandwidth	=	-4 dB
Meter Reading, Signal input, narrow bandwidth	=	-13 dB
Signal Input Meter Reading Difference		9 dB
Meter Reading, Impulse input, wide bandwith	=	-4 dB
Meter Reading, Impulse input, narrow bandwidth	=	-14 dB
Impulse Input Meter Reading Difference		10 dB

Since the signal input reading difference (9 dB) is within 2 dB of the Impulse Input Reading Difference (10 dB), the signal is classified as wideband, and wideband limits are to apply.

8.5.5 Accurate Signal Amplitude Determination Using the SPD-125

If a received signal is determined to be close to the spec limit, it may be necessary to make a more accurate amplitude measurement to determine whether the limit has been exceeded. This may be done by making an X-Y recording on a Master Calibration Plot (a procedure to be described later), making a fixed-frequency, two-terminal amplitude measurement using only the EMC-25, or by drawing the actual limit level line on the face of the SPD-125's screen. This last method is to be described here.

A. At each of the three calibration frequencies within the desired band, as listed in Column C of Tables 3002-1 or 3002-2, determine an impulse generator level which will exactly match in amplitude the MIL-STD-826A limit level at these frequencies. This is done as follows: To the limit level as listed in Column G, add the top line impulse generator level as listed in Column I, or Column J if the CLC-25 is used. From this total, subtract the top line equivalent current level as listed in Column L. (X = G + (I or J) - L)

B. Set the function switch of the SPD-125 to "Locator". Set the EMC-25 Attenuator control to the value listed in Column H of the appropriate calibration table. Set the Frequency Tuning Control of the EMC-25 to the low frequency calibration point listed in Column C.

C. Set the impulse generator calibrator level to the output determined in (A) above for the lowest calibration frequency and feed the impulse signal into the EMC-25.

D. With a grease pencil, place a calibration point on the screen of the oscilloscope. The horizontal position of this calibration point is determined by the center of the brightened "Locator" marker on the trace. The vertical coordinate of the calibration mark is determined by the peak amplitude of the pips caused by the impulse generator at the point marked by the locator.

E. In a similar manner, plot the highest frequency limit level point. Set the EMC-25 tuning to the highest calibration frequency (Column C), set the impulse generator to the highest frequency impulse level as established in A, and plot the point using the "Locator" marker as the X coordinate, and the top of the impulse pips as the Y coordinate.

F. Plot the center frequency calibration point in the same way.

G. While maintaining an impulse generator level at the center-band frequency level, with a grease pencil draw a smooth curve through the three calibration points. This curve should intersect each of the calibration points, and its general curvature should correspond to any impulse pip amplitude changes which may occur across the screen.

H. Remove the impulse generator input and reconnect the current probe.

I. With the current probe clamped around the conductor under test, carefully note the relationship of any responses to the plotted limit line, to determine whether the responses in question are within limits.

8.5.6 Measurements of Other Conductors

Repeat the measurement procedure described in Sections 8.5.1 through 8.5.5 on each lead or cable on which measurements are required, noting the frequency, amplitude and classification of any out-of-limit responses. If any responses are noted which are 10 dB or more above the limit, the person responsible for the test should be notified at once. He may wish additional measurements made in an attempt to determine the source of the interference, or he may wish the test terminated until corrective action is taken.

8.5.7 Measurements of Other Frequency Bands

When all the measurements are completed on this band, switch to the next higher frequency band. Amplitude calibrate the EMC-25 for this new band (Section 8.4.5), clean the oscilloscope screen of any grease pencil markings, and establish the new reference peak noise levels of the scope trace (Section 8.6.2). Repeat the measurements on all the required conductors and cables (Sections 8.6.3 through 8.6.6).

8.5.8 Repeat the measurements for each frequency band required.

8.6 Procedure for Making X-Y Recordings of Measurements

8.6.1 General

The procedure for scanning the frequency spectrum using the Spectrum Display Module described in the preceding section is intended as a relatively fast means of determining if out-of-limits responses exist. This allows troubles to be located and cor-

rected before the time-consuming procedure of recording the responses on an X-Y Recorder is undertaken. The X-Y recording provides a permanent record of all of the responses across the frequency spectrum.

8.6.2 Procedure For Making Broadband Conducted X-Y Recordings

A. The equipment is set up and calibrated according to Sections 8.3.1, 8.3.2, 8.3.3, 8.3.4, and 8.3.5.

B. Place a copy of the Band #1, Broadband, Method 3002 Master Calibration Plot on the recording surface of the X-Y plotter. Section 8.2 describes the procedures used to make this calibration master. Position the Calibration Master in the horizontal center area of the plotting surface, with the lower edge of the paper carefully positioned against the lower paper guide of the plotter.

C. The frequency indicator dial of the EMC-25 is to be positioned so that it is against the mechanical stops at the extreme lower frequency end of the dial. Turn the Power switch of the X-Y Recorder to On. Slide the plotting paper horizontally across the plotting surface until the left-hand border line of the paper is positioned under the recorder pen.

D. Turn the attenuator control of the EMC-25 to the position called for in Column H of Table 3002-1. For band #1 this setting is 20 dB (Cal). Set the EMC-25 tuning control to a center-band frequency. The current probe (PCL-25) is not now to be clamped around a conductor. Turn the power switch of the recorder to ON. The pen of the X-Y plotter should now be positioned approximately over the "noise" calibration line of the Calibration Master. If this is not the case, check the setup and calibration of the system.

E. Now determine from Table 3002-1 the impulse level input required to cause a

pen position corresponding to the top calibration line of the Calibration Master. If an external impulse generator is used, this level is listed in Column I, and if the CLC-25 is used, this level is listed in Column J. For band #1 this level is 83 dBuV/MHz for both cases. Insert an impulse generator output of this level into the input of the EMC-25. The pen of the recorder should be positioned over the top calibration line of the Master. If this is not the case, recheck the calibration of the system.

F. Clamp the Current Probe around the first conductor of the Test Sample on which measurements are to be made.

G. Set the EMC-25 Attenuator to the position listed in Column Q of Table 3002-1 (for band #1 this setting is 60 dB). Turn the Dump control slightly clockwise, turning the Dump ON, but maintaining the longest "hold" time.

H. Hold in the "Sweep" button on the EMC-25. Put the tuning mode switch of the EMC-25 in "Sweep" position. When the plotter pen has stabilized its position near the left-hand border of the plotting paper, place the pen position switch of the plotter in its Down position, and release the Sweep button of the EMC-25.

I. The recorder's pen will travel slowly across the plotting area of the paper, inking a line. Except where conducted interference picked up from the conductor under test causes a deflection of the pen, this line should be close to or coincidental with the "noise" line of the Calibration Master.

J. When the pen has reached the right-hand border line of the plot paper, change the pen position switch of the recorder to its Pen Up position. Return the Power switch of the Recorder to Standby.

8.6.3 Inspection of the Recording

Before removing the recorded Calibration Master from the Recorder, study it

to determine the following:

A. Is the inked line discontinuous at any point, indicating faulty ink flow in the pen?

B. Are any above-limit signals recorded?

C. If out-of-limit signals are observed, were these responses noted when the spectrum was scanned with the Spectrum Display Module?

D. Has the classification (broadband or narrowband) of any observed out-of-limit signals been established during the spectrum scan?

8.6.4 Information To Be Included On The Recording

If no out-of-limit signals are observed, or if all out-of-limit responses have been previously identified and classified, the recorded Master may be removed from the plotter. The following information should be included on this master:

A. Model and serial of the test sample.

B. Identification of the conductor measured.

C. Information concerning the company or person for whom the test was run, and any special identification of the test performed.

D. An explanation of any special circumstances, etc. concerning the test.

E. Name of operator and date of test.

F. Identification of any out-of-limit responses as to classification.

8.6.5 Identification of Transient Responses

If out-of-limit responses have been recorded which were not observed when the spectrum was scanned with the SPD-125, the possibility exists that the recorded response was caused by a transient. To determine if this is the case, turn the Power switch of the

recorder to Operate. Hold in the Sweep button of the EMC-25 until the pen returns to the left-hand border of the paper, then release this button. Do not place the pen position switch in its Down position. Observe the motion of the pen as it moves across the paper, paying special attention as it approaches the region of the unidentified response. If the pen motion retraces the outline of this response, it is identified as a steady-state signal. However, if no response is indicated during this second sweep, the recorded response is either transient or intermittent, and should be so identified.

8.6.6 Bandwidth Classification of Recorded Responses

If any out-of-limit responses have not previously been identified as to classification, this should be done at this time.

A. Turn the Tuning Mode switch of the EMC-25 to Manual and turn the Dump switch to OFF (Fully CCW). Turn the Power switch of the recorder to ON. Adjust the tuning of the EMC-25 until the pen of the recorder is positioned at the peak of the response to be classified. Carefully fine-tune the EMC-25 for a maximum meter reading on the front panel meter. Note this meter reading. Switch the Bandwidth switch of the EMC-25 to Narrow. Again tune for a maximum meter reading, and note the reading. Determine the difference between these two measurements.

B. Now inject the output of an impulse generator into the input of the EMC-25. Adjust its output for a meter reading on the EMC-25 which is approximately the same as the narrow bandwidth signal reading previously noted. (If the impulse generator does not have sufficient output for this, set its level for maximum output). Note the meter reading. Next, turn the Bandwidth switch of the EMC-25 back to its "Wide" bandwidth position, again, note the meter reading, and determine the difference between these two measurements.

C. If the difference in meter reading in response to a signal, is within 2 dB of the difference in meter reading with the impulse generator input, the signal is to be classified as Broadband.

D. If the difference in meter reading in response to a signal varies by more than 2 dB from the difference with an impulse input, the signal is to be classified as Narrowband. See Section 8.5.4 for examples of this procedure.

E. On the Master Calibration Chart, note the bandwidth classification of each recorded out-of-limit signal.

F. Remove the Calibration Master from the plotter, and include on it all of the pertinent information concerning the test. Section 8.6.4 describes the type of information required.

8.6.7 Measurements on Other Conductors

Position a new Calibration Master Plot for the same band on the plotter. Clamp the Current Probe PCL-25 around the next test sample conductor to be measured and repeat the plotting procedure (Sections 8.7.2 through 8.7.7). Repeat the process for each of the test sample conductors on which measurements are required.

8.6.8 Narrowband Conducted X-Y Recordings

A. The procedure for making the narrowband conducted measurements is identical to the procedure for making the broadband conducted measurements, as described in Section 8.6 through 8.6.7 with the following exceptions:

1. The Master Calibration Chart to be used is to have the limit level for narrowband conducted interference plotted on it.

2. The table to be used to determine the impulse generator and attenuator settings is Table 3002-2.

3. Since most, if not all, of the out-of-limit signals identified when the broadband recordings were made will also be out-of-limits for this narrowband measurement, the bandwidth classification of these signals can be quickly determined by referring to the broadband conducted Master Cal Chart,which was previously recorded for the frequency band and test sample conductor now being measured.

B. Plot a separate narrowband recording for each of the test sample conductors on which measurements are required. Include all the pertinent information on each of the recordings. Section 8.6.4 describes the type of information required.

8.6.9 Measurements on Other Frequency Bands

After recordings have been made for both broadband and narrowband conducted interference on all of the required conductors of the test sample, change the bandswitch of the EMC-25 to its next higher position, and repeat all of the measurements as outlined in Section 8.6.2 through 8.6.8 for this new band setting. Repeat the measurement procedures on each frequency band until broadband and narrowband readings have been made on all of the frequency bands up to 100 MHz (band #12), or as required.

8.7. Use of the Completed X-Y Recordings

When completed, the set of X-Y recordings provides a permanent complete record of the frequency, amplitude and character of all conducted interference signals generated by the test sample within the frequency range of from 14 kHz to 100 MHz. Besides being used as proof of conformity to the specification limit, the recordings can be used to help locate and identify the source of problem areas, and suggest engineering changes which may improve the operation of the system.

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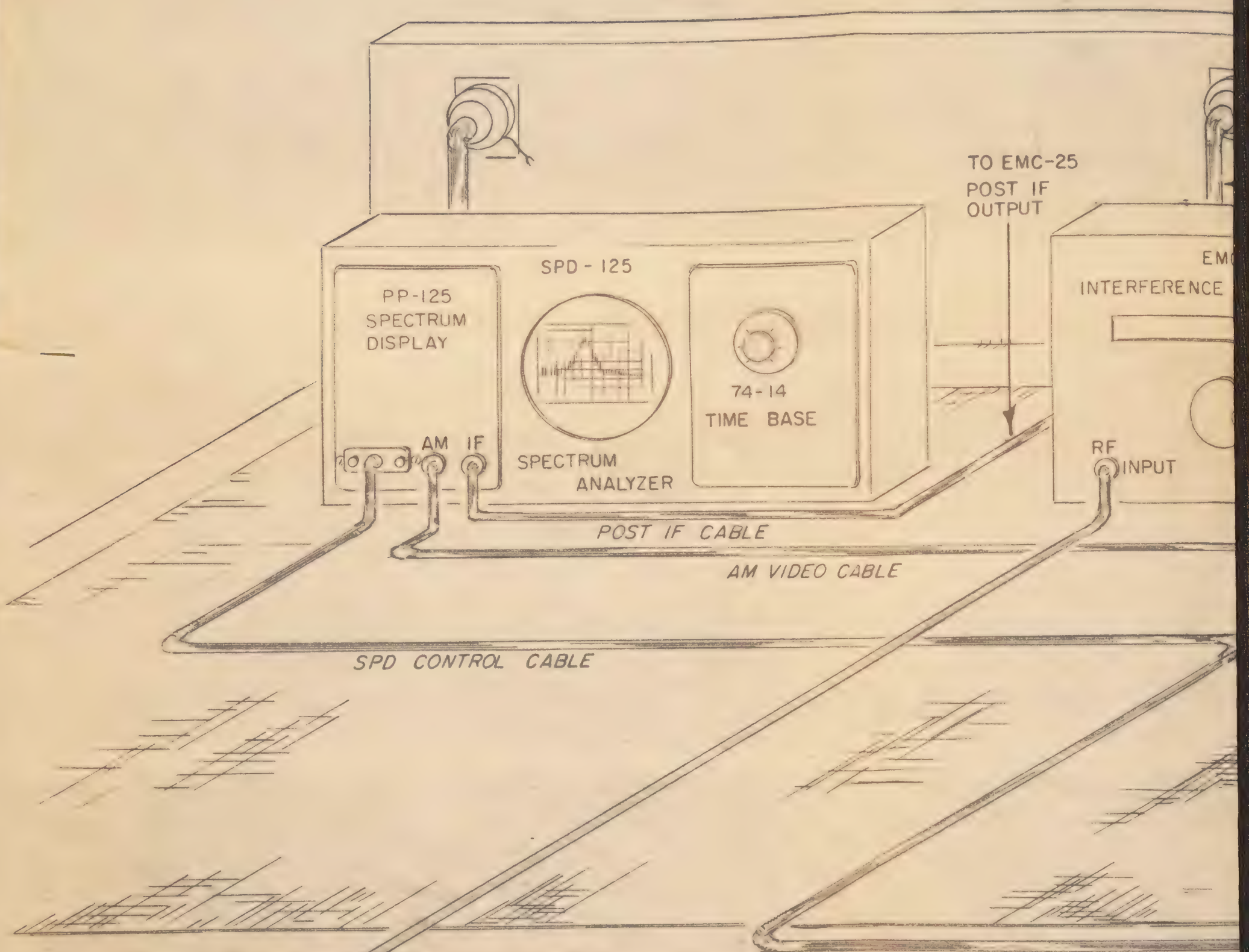

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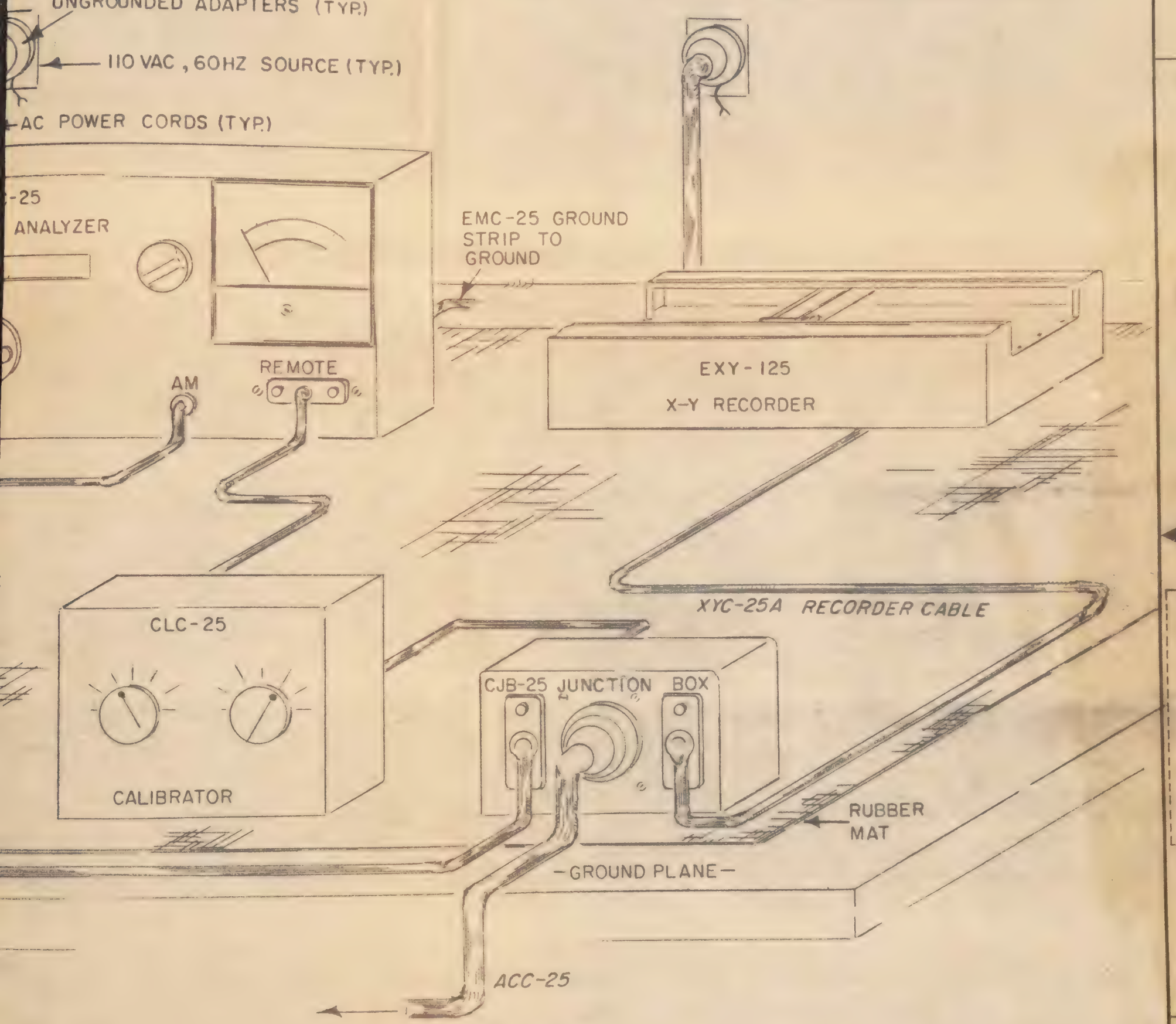

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SCALE	NO. REQ'D	DRAWN DATE	SIZE: — DRAWING NUMBER: FIGURE 8.1 — ISSUE: —
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		APPROVED DATE	

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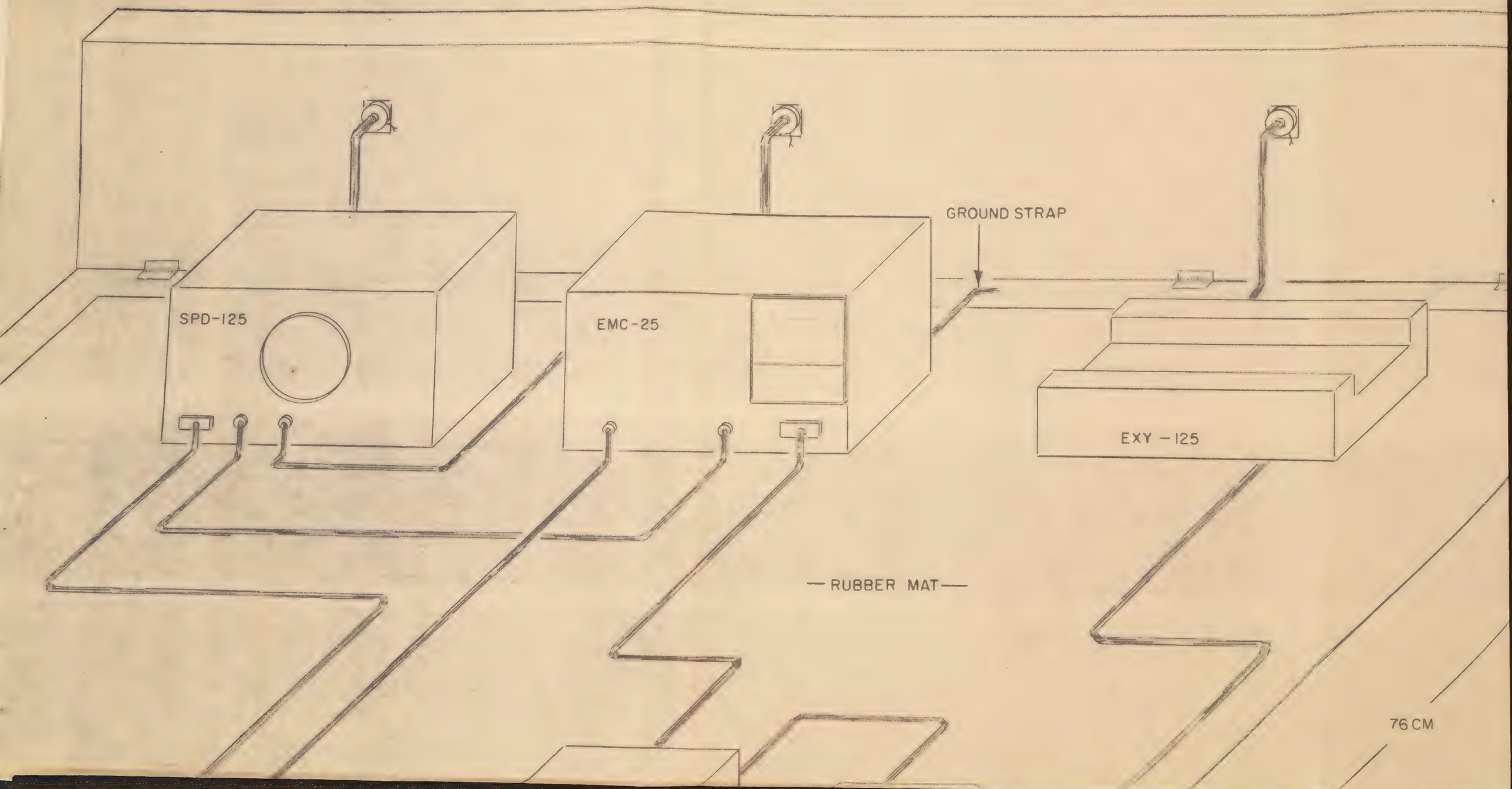

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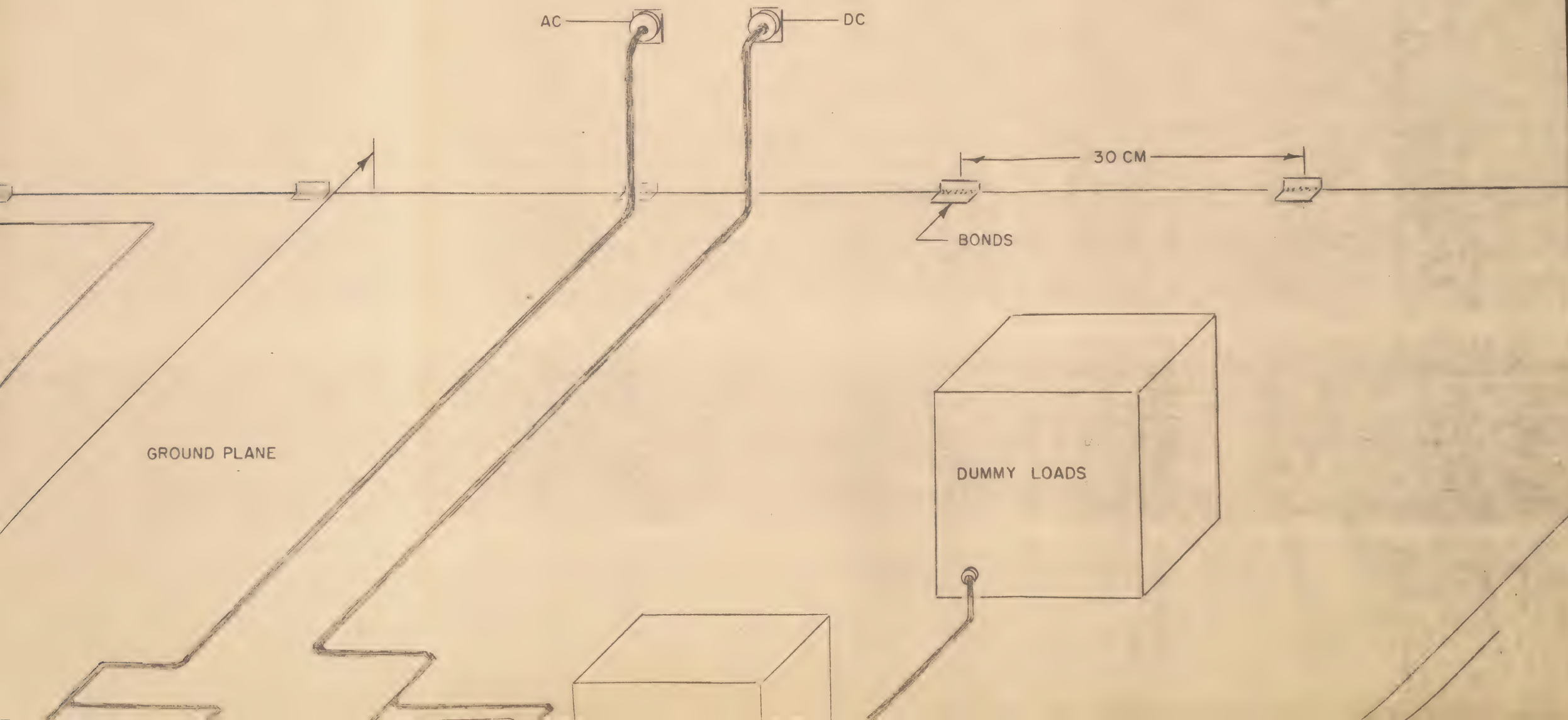

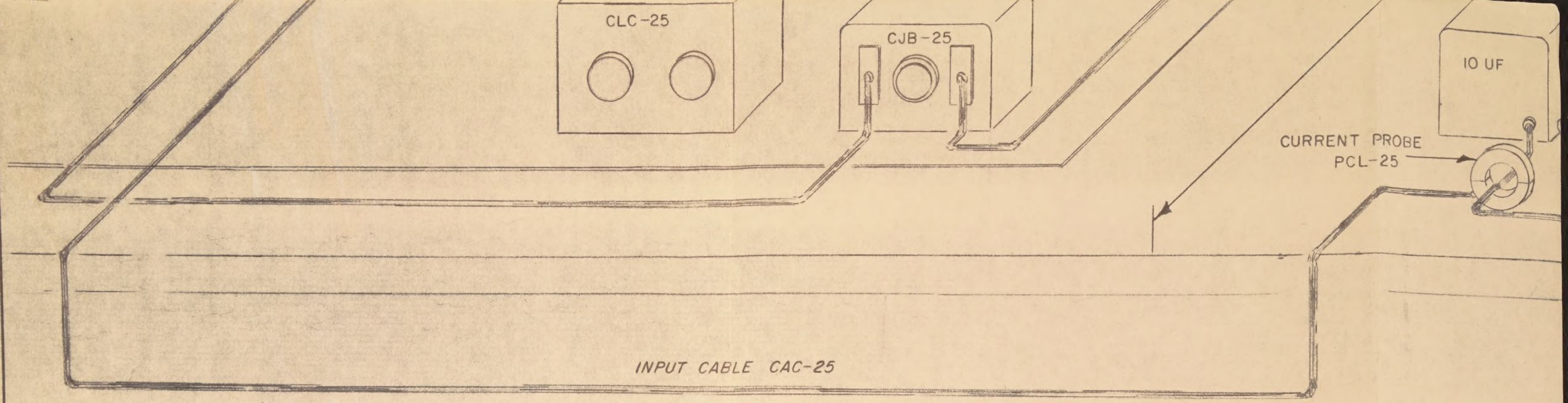

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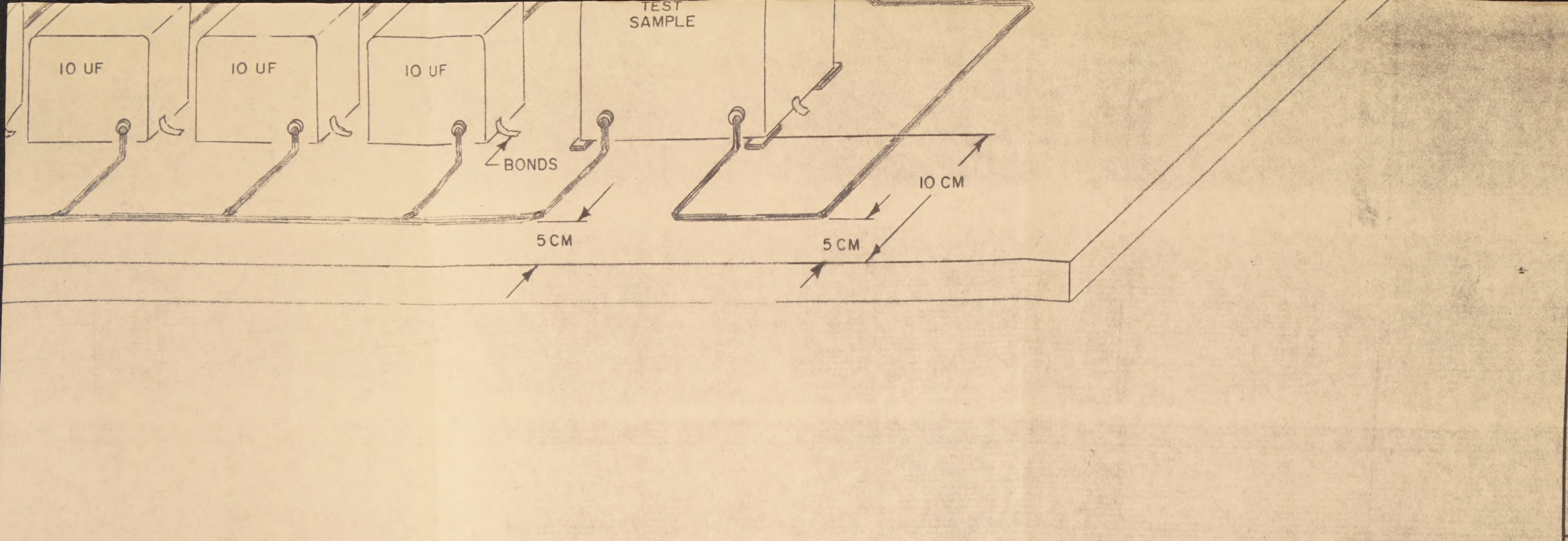

MATERIAL	FINISH	HEAT TREAT
		WEIGHT

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		
FRAC.	DEC.	ANG.
± 1/64	± .005	± 30′

TITLE: SAMPLE TEST SETUP CONDUCTED MEASUREMENTS MIL. STD. METHOD 3002

FAIRCHILD
ELECTRO-METRICS CORPORATION
A SUBSIDIARY OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
AMSTERDAM, N.Y.

SCALE	NO. REQ'D
NEXT ASSY.	

		SIZE	DRAWING NUMBER	ISSUE
DRAWN	DATE			
CHECKED	DATE		FIGURE 8.3	
APPROVED	DATE			

B

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MP MASTER
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